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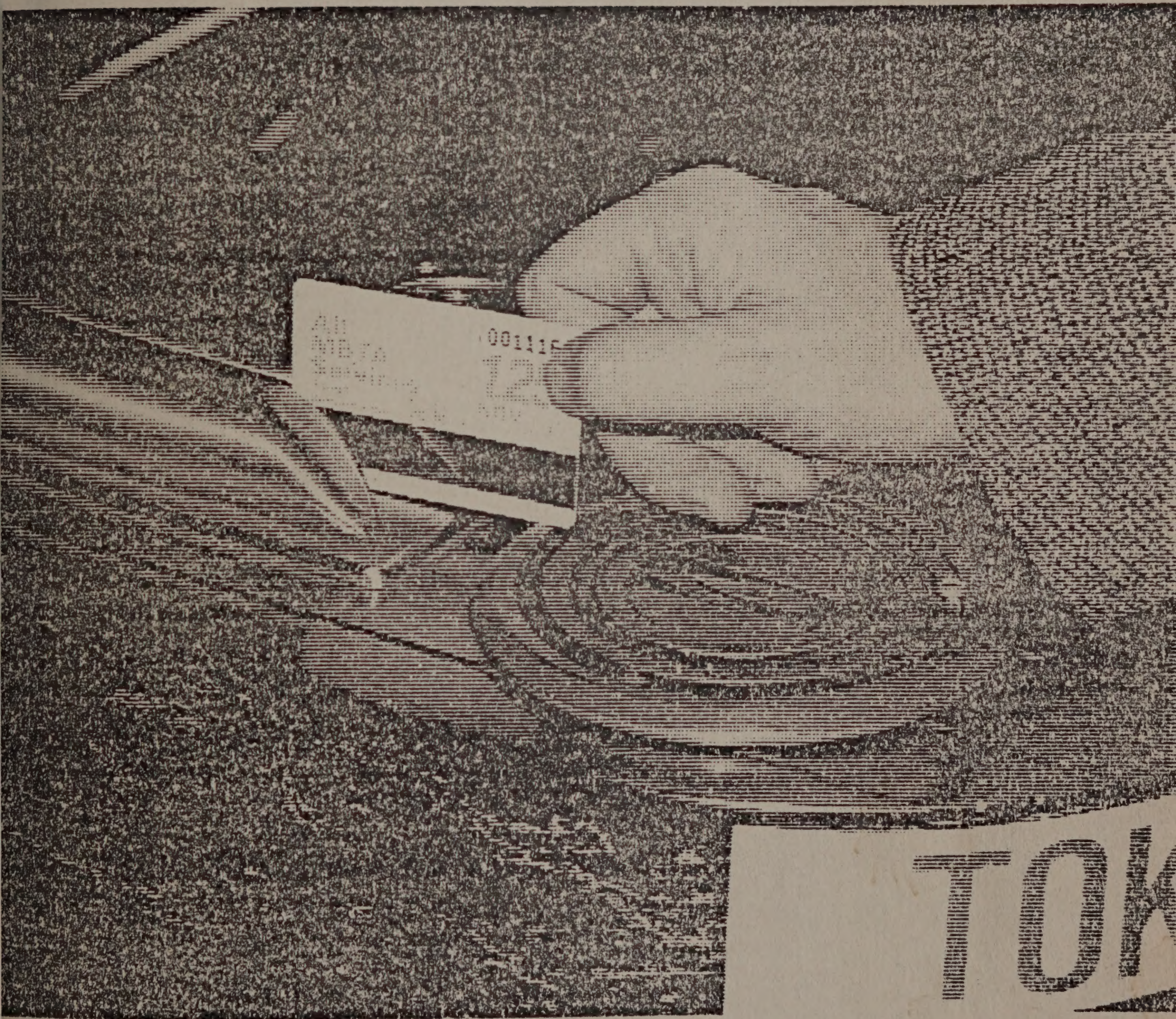

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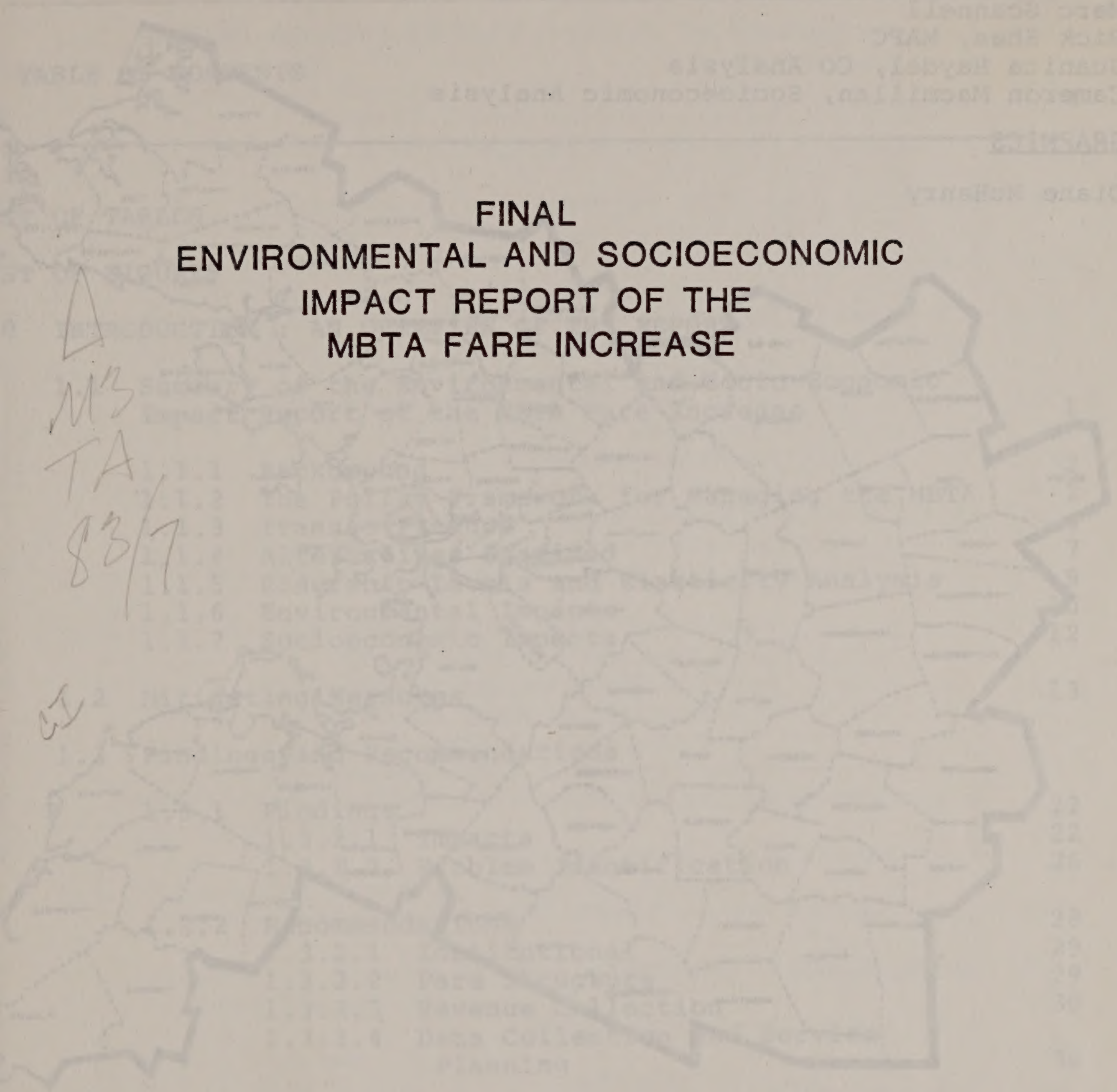

FINAL
ENVIRONMENTAL AND SOCIOECONOMIC IMPACT REPORT OF THE MBTA FARE INCREASE

MBTA
83/1

December 1983

This document was prepared by **CENTRAL TRANSPORTATION PLANNING STAFF**, an interagency transportation planning staff created and directed by the Metropolitan Planning Organization, consisting of the member agencies.

Executive Office of Transportation and Construction
Massachusetts Bay Transportation Authority
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PREPARED FOR THE BENEFIT AND USE OF THE MUNICIPALITIES CONSTITUTING THE BOSTON METROPOLITAN AREA PLANNING DISTRICT

AUTHOR(S)

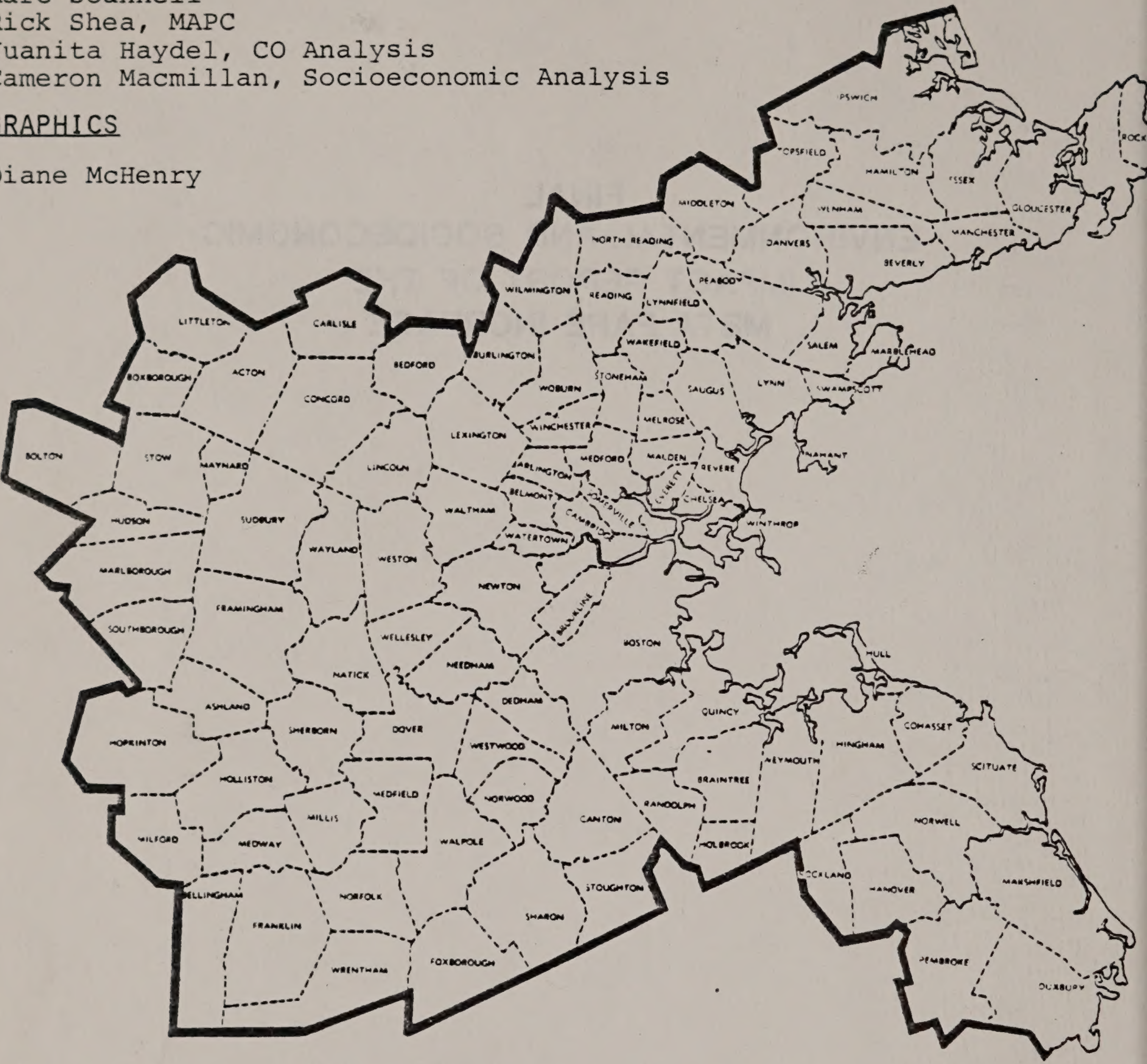
Sonia Weinstock, Project Manager
Deborah Schreiber
Katrina Kalish
Marc Scannell
Rick Shea, MAPC
Juanita Haydel, CO Analysis
Cameron Macmillan, Socioeconomic Analysis

SECRETARIAL ASSISTANCE

Maureen Hegarty
Barbara Julian
Sandra Barron

GRAPHICS

Diane McHenry



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Copies may be obtained from Central Transportation Planning Staff, 27 School Street, Boston MA 02108

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1.0 INTRODUCTION

AN OVERVIEW OF THE REPORT

This report presents a description and analysis of the impacts associated with a 1981 fare increase on the rapid transit and bus lines operated by the Massachusetts Bay Transportation Authority (MBTA). Both the environmental and socioeconomic impacts are presented in this report.

Section 1 is a summary of the report. It includes the background financial conditions which required that action be taken, the alternatives examined, the anticipated environmental and socioeconomic impact of the chosen alternative (a fare increase), and information on ridership levels as forecast and as found through the 1981 Fare-Mix Sampling Program.

Section 2 of this report describes the existing system and outlines service cuts and fare changes. Next, this section presents a historical review of ridership and fare levels on the MBTA. Finally, operating costs and funding sources are discussed.

Section 3 presents a review of the impacts of the August 1981 fare increase on ridership. These changes are presented in terms of an elasticity analysis.

Section 4 provides an estimate of the environmental impacts of the recent fare increases. The air quality impacts are analyzed in both a regional and a localized context. Energy impacts are also described.

Alternative fare structures are presented and analyzed in Section 5. Included in the review are such strategies as peak period pricing, reduced rates for transfers, and alternative fare collection techniques.

Section 6 discusses the socioeconomic impacts. Where possible, the impacts are disaggregated to isolate the effects on specific target groups; the impacts are quantified where appropriate. This section has been designed to fulfill the requirements of a Socioeconomic Impact Report and addresses the issues outlined in the scope of work provided by EOEA.

Section 7 is concerned with the mitigating measures aimed at reducing the adverse impacts of fare increases. Changes in fare policy and collection, service and its quality, management, planning, and efficiency are all included. For each, the MBTA level of commitment and a schedule for achievement is provided.

Section 8 examines the short- and long-term outlooks for stabilized fare and service levels at the MBTA and provides suggestions and recommendations for action should future fare changes be necessary.

1.1 SUMMARY OF THE ENVIRONMENTAL AND SOCIOECONOMIC IMPACT REPORT OF THE M.B.T.A. FARE INCREASE

This report presents an analysis of the impacts associated with the 1981 fare increase on the rapid transit and bus lines operated by the Massachusetts Bay Transportation Authority (MBTA). Both the environmental and socioeconomic impacts are presented in this report.

1.1.1 Background

The study was required as part of an agreement between the Executive Office of Environmental Affairs (EOEA) and the MBTA. EOEA permitted the MBTA to increase fares on August 1, 1981, prior to completion of environmental review, provided, among other items, that the MBTA complete an Environmental Impact Report (EIR), a Socioeconomic Impact Report (SEIR), and a Management Practices Study. This report fulfills the requirements for both the EIR and SEIR.

The scope of this report is somewhat unusual in that ordinarily an EIR would contain predictive information on environmental impact in advance of the implementation of the change. Thus, no data on the results of the action usually accompanies the EIR. In this case, however, much of the analysis occurred concurrently with both the fare increase and the subsequent decrease in fare levels. This timing has allowed for some of the new ridership (post-increase) estimates and associated impacts to be derived as the result of a direct fare mix sampling study conducted in November of 1981. Environmental data provided is solely from computer simulation modeling efforts, and does not include any sampling or data collection performed after the increase commenced; however, the results of the 1981 ridership sample were used as model inputs. The study was conducted by the Central Transportation Planning Staff (CTPS) at the request of the MBTA.

1.1.2 The Policy Framework For Managing The MBTA

The MBTA is a transportation operating agency. As such, its primary concern is to maximize ridership while minimizing rises in costs. The following goals, stated in the 1978 Program for Mass Transportation of the MBTA, provide the MBTA management with both overall directional goals and some specific objectives which indicate the achievement of these goals.

Management Goals:

- Increased Riders. To attract additional riders who can be served at reasonable cost in relation to present costs per rider.

- Control of Overall Financial Burden. To bring under control the overall costs of supplying public transportation and to seek an equitable distribution of the resultant financial burden among riders and public revenue sources.

- Improved Quality of Service. To improve the quality of service offered, where this is possible without unreasonable increases in costs per rider.

- Unit Costs and Productivity Improvement. To reduce the cost of supplying a desirable level of public transportation service and to increase the level of service provided at a given expenditure level.

- Improved Safety and Security. To reduce the hazards to which riders and employees are exposed in connection with public transportation service.

- Equitable Fares and Service. To implement a fare structure and fare level which are equitable in terms of price per value received and to apply uniform criteria for the establishment and discontinuation of service.

Social Goals:

The MBTA is also an agency of government. Consequently, it must serve the public in an environment shaped by society's demands as expressed through its elected officials. It should be responsive to at least the following social goals:

- Provision for Riders with Special Needs. To provide transportation service for the elderly and handicapped persons, particularly those who do not have ready access to an automobile.

- Environmental Improvement and Fuel Consumption. To reduce air pollution, noise pollution, other forms of environmental degradation, and fuel consumption associated with supplying public transportation service.

- Equal Opportunity/Affirmative Action. To remedy the effects of any illegal discriminatory practices in the MBTA, to eliminate such practices, and to take positive action so that the MBTA work force reflects the racial and sexual composition of the population where the jobs exist.

- Economic Recovery. To contribute to the reduction of the unemployment rate in Massachusetts and stimulate the depressed economy through a large scale capital investment program.

- Land Use and Development. To contribute to and facilitate the process of land use planning and development for the long term.

Furthermore, the 1978 PMT directly discusses the costs which some goals may entail:

> "It is important to recognize that achievement of social goals may impose costs on the MBTA which are in excess of those associated with a strictly operating efficiency criterion. Investment of resources for social purposes produces returns, but not ones as easily identified as more riders or lower costs. Therefore, a dilemma facing the MBTA and the public will be how to share more equitably the burden of MBTA cost. Within the MBTA's control is the ability to achieve greater efficiency in both operations and construction, in order to stabilize the relationship between fare revenues and operating costs. Yet to be resolved is how the public will choose to share in the increasing costs of the MBTA as a means for achieving social goals."

1.1.3 Transit Finance

The MBTA fare increase of 1981 was implemented in a changing financial environment for mass transportation. The implications of financial pressures created by changing public policy and their impact on transit fares are discussed below.

MBTA Finance

In fulfilling its mandate to provide mass transportation service, the MBTA incurs costs which must be financed through a number of sources. The MBTA's costs are reflected in an annual budget. The budget is, in turn, developed to insure that total costs and the amount of funds available for the MBTA are equal. In achieving this equilibrium, there is an interplay of a number of variables. On the cost side, increasing fixed costs associated with capital investment, inflation and its impacts on the price of fuel, materials and labor, and an objective to provide the maximum amount of service all result in pressures for increased costs. On the funding side, the overall public policy objective of minimizing public finance (taxes) has created pressure to minimize MBTA funding from standard revenue sources.

Budget

Heightened pressure to contain costs has resulted in strict budgetary limitations in recent years. One outcome of these limitations has been a concerted effort to reduce costs through more efficient utilization of resources as well as through service reductions. Some costs, however, such as principle and interest on long-term bonds are "fixed" and cannot be reduced. Also, the price of supplies is generally "fixed" and cannot be reduced. The two principal methods of cost reduction which have been successful are more efficient utilization of resources and service reductions. (Efforts to control costs are addressed in greater detail in the Management Practices Study.)

Funding

On the funding side of the equation, the MBTA receives support at four levels: Federal, state, local communities, and consumers.

The Federal government provides funds for 80% to 85% of the cost of MBTA capital improvements (these Federally reimbursed costs are not reflected in the MBTA's annual operating budget). The Federal government also provides financial assistance for transit operations. In recent years, the Federal government has reduced the amount of funding available for operating assistance to a current value of only 7% of total funding. As a result, financial assistance from the state has become the greatest source of MBTA funds at approximately 39%. Cities and towns within the MBTA district also contribute to the MBTA's financing through a series of assessment formulae. Communities outside the MBTA district fund the net cost of service which they receive. Proposition 2½ has, however, limited the amount of financing available from communities.

Lastly, consumers are a significant source of MBTA income. Consumers are comprised of those who lease property from or pay for advertising, on the MBTA, and the bulk of MBTA consumers--the ridership. It is this final group, the riders, who are most directly effected by the many actions addressed in this report.

Fare Revenue

The revenue provided by the transit rider, who contributes to MBTA funding through the fare box, is of primary importance in this report.

As a contribution to the financing of the MBTA's total operating expenses, fare revenues declined from 55.6% in 1970 to 26.0% in 1980. Additionally, the average fare per passenger as adjusted for inflation had declined from 30.2 cents to 16.7 cents. In the same decade, the actual cost of gasoline, a major component of the cost of transit's competition, the automobile, had nearly quadrupled while transit fares had increased by approximately one-third.

With Federal, state and local funding sources restricted and with further cost reductions liable to produce unacceptable service levels, the MBTA advanced a fare increase as a means of increasing the funds available for transit operations.

The achievement of a fare revenue goal is dependent on a number of variables. Simplistically, the pricing schedule and number of passenger trips will dictate the amount of revenue to be gained. The number of passenger trips, however, is dependent upon a number of variables in addition to the price of transit. These variables impact transit ridership in both the long run and short run. Among the more significant variables are population and employment levels and patterns. The extent and distribution of people and jobs are major determinants of total trips made by people. Declining population in inner city areas has contributed to declining transit ridership in recent decades. The characteristics of the alternative to transit also affect transit ridership. In the long run, increased auto ownership and availability has provided more travelers with the option of driving. Stable gasoline prices and more fuel-efficient automobiles have reduced the cost of driving in recent years, making driving more attractive. Parking supply and pricing conversely affect the option of using the automobile.

All of these variables, which are beyond the control of the transit manager, affect the level of transit ridership and, in turn, transit revenue. The impact of these variables on transit ridership is difficult to measure, particularly in the short run, and have not been addressed in this report.

Two major ridership variables over which the transit operator has some control are service and price. These variables are addressed in this report. Although the objective of this report is to address the impact of the 1981 fare increase, there have been significant changes in transit service during the same period, and it has been necessary to isolate the impacts of these changes to properly account for the impacts of the fare increase.

Transit fares were increased in 1981 in a direct attempt to increase fare revenue as one element of the MBTA's funding schedule to provide sufficient funds to finance the cost of the MBTA's annual budget. This report assesses the impact of the fare increase with respect to MBTA goals of maximizing transit ridership and improving the environment.

1.1.4 Alternatives Examined

The study scope required the identification and analysis of No-Action and Implementation-Action alternatives as well as several alternative actions to the fare increase as implemented.

The No-Action alternative presents the case that would have occurred had a fare increase not been implemented. According to the MBTA, two possible results of inaction were: a reduction of all service levels shortly after August 1, 1981 or the termination of all service for approximately the months of November and December. Failure to implement a fare increase or reduce service would result in an estimated 1982 budget shortfall of $35 million over that of 1981.

The Implemented-Action alternative is composed of a systemwide fare increase and a series of service restorations instituted at the start of the Fall schedule. In April of 1981, the MBTA reduced service in an effort to alleviate financial problems. With the goal of meeting a 1981 budget, the MBTA Board of Directors adopted a revised schedule with service changes aimed at reducing total manpower requirements by 20% (or approximately 300 surface operators). This set of service reductions, concentrating on the high cost and low ridership MBTA-run and MBTA-subsidized transit services, was initiated during the first quarter of 1981.

A variety of actions were proposed for examination and included strategies such as alternative fare structures, alternative fare payment methods, alternative fare collection systems, legislative programs and alternative funding sources. The bulk of the alternative actions presented are directed toward increasing revenue or ridership associated with specific groups of users (i.e., commuters, elderly, etc.). The actions identified are as follows:

- Peak period pricing is simply the policy of maintaining lower transit fares during off-peak hours. The primary goal of this policy is to increase ridership during the hours that excess capacity exists. The greatest drawback of this policy is that a decrease in off-peak fares leads to a decrease in fare revenue. The impact of this policy on ridership has varied widely from city to city, with Boston showing little or no gain in revenue.

- Off-peak fares for the elderly have been in effect on the MBTA since August 1981. Senior citizens are allowed to ride free between 9:30 AM and 4:00 PM. This program had increased elderly ridership by an estimated 27,000 passengers per day at a cost of $5,000 in lost revenue. (This was ended in December of 1982 when an all-day ten cent fare was instituted by legislative action.)

- Peak period surcharge involves charging a premium for peak period trips to compensate for the additional cost of transporting passengers during this period. This policy would take advantage of the low fare elasticities exhibited by commuters.

- Reduced fares for special groups can be justified in several ways. They can be made available to groups that are considered less capable of paying, such as people of low income and the elderly. In 1979, it was estimated that 23.8% of MBTA passengers had household incomes under $8,000. They may be provided to increase the attractiveness of transit to specific groups such as the handicapped. In addition, lower fares are often used to encourage trips that are deemed to be "in the public good" such as school trips. These actions generally stimulate ridership among the targeted group(s) at the cost of decreased fare revenue.

- Reduced fares for transfers is suggested as an equity measure to offset the relatively high price of short transit trips requiring one or more transfers. Transfer fares may range anywhere from free to full fare. Some transit facilities discount all transfers between vehicles while others limit it to specific combinations (e.g., express bus-rail). Such a plan by necessity implies a gain in ridership coupled with a loss in revenue. Additionally, utilization of paper transfers has historically been difficult to control, subject to abuse, and an added administrative burden.

- Lower fares for downtown travel have been adopted by many cities as part of their downtown revitalization plans. Low fares on downtown loops may reflect a low cost due to limited route length, high density of use, or the lower incremental value of intra-downtown trips to the individual user. In some cities, downtown merchants contribute to the financing of the system. The negative impact of such a system is the loss of revenue from those riders already making trips within the Central Business District.

In addition to the above alternatives, several alternative payment systems have been considered. They are as follows:

- Electronic fare collection systems can be used to set fares by time of day or distance between stations. Tickets purchased at vending machines or outside agents are required to enter and exit the system. Problems associated with this system include equipment failure and the difficulty of implementation for on-vehicle payment (LRV and buses).

- The bulk sale of tokens at a discount allows for effective transit marketing and reduced coin handling costs.

To date, this method had not been implemented due to significant problems with the administration of the sales of bulk tokens.

- Self-service fare collection holds each passenger responsible for determining and paying his own fare. Benefits include increased productivity, the opportunity to introduce a diversified fare structure, lower fare collection costs, and improved passenger statistics. Problems surrounding the implementation of this policy include the high capital cost of ticket vending and verification machines, machine malfunction and vandalism, and enforcement.

1.1.5 Ridership Levels and Elasticity Analysis

Service reductions and fare increases have had a negative effect on MBTA ridership levels. The rider's response to these changes, quantified in terms of elasticities, depends on several factors including: the proportional change in the fare or service levels; trip characteristics such as sub-mode used (bus or rapid transit); time of travel or trip purpose; the socioeconomic characteristics of the rider such as age or income; and the cost characteristics of alternative modes.

In order to summarize the general effects of a fare increase, a review of the effect of fare increases in other cities was carried out. This review reaffirms the conclusions of Curtin (1968) that the ridership response to fare increase is somewhat inelastic, i.e. ridership change is proportionally smaller than the fare change.

A comparison of MBTA ridership levels before and after the fare increase indicates that approximately 90,200 fewer trips were made on an average weekday in November 1981 after implementation of the fare increase than in November 1980. This figure represents about 15.0 percent of the MBTA's total average weekday trips.

These trips may be further broken down according to the reason for the decline:

-56,700 fewer trips (9.4%) - directly due to the fare increase of August 1981

-32,000 fewer trips (5.3%) - due to service cuts

- 1,500 fewer trips (0.2%) - due to bus replacement on the Mattapan High Speed Trolley Line

The most significant changes in the types of riders, were the increase in the number of elderly riders mainly due to free off-peak fare; the increase in the number of pass users; and the decrease in the number of riders who pay the full adult cash fare. The smallest impact was on riders who use only rapid transit. The greatest loss was in the number of trips made using both rapid transit and bus for a single trip.

Bus and rapid transit elasticities were calculated from the change in ridership and fare levels before and after the fare increase. After adjustments were made to isolate the effects of the service reduction from the effects of the fare increase, the fare elasticities were compared with past experience in Boston and other cities. While bus elasticities seem to be in agreement, those for rapid transit were significantly higher than anticipated. This implies that other forces such as a decrease in service reliability and the composite effect of the 1980 and 1981 fare increases might have been acting to discourage ridership.

Elasticities can be a valuable tool in projecting the impact of service or fare changes on ridership levels, given that all the other variables affecting ridership remain unchanged when the fare change occurs.

1.1.6 Environmental Impacts

The most significant environmental impacts that would tend to result from a fare increase relate to changes in air quality and energy consumption. As the cost of public transportation increases and travelers turn from transit, they must either take some other mode of transportation for that trip or not make the trip. If passengers switch to either private automobiles or taxis, the total number of vehicle miles traveled (VMT) as well as highway congestion will increase, causing emissions and energy consumption to rise.

The magnitude of air quality impacts was estimated using an analysis method that considered three types of changes:

1. the change in total regional VMT

2. the change in congestion (queue length) on major Boston radial highways

3. the change in traffic volumes at selected intersections designated as CO (carbon monoxide) Hot Spots

The combined ridership loss due to the fare increases of July 1, 1980 and August 1, 1981 was used in this analysis to estimate the number of passengers diverted from transit to private automobiles or taxis.

Additional regional VMT was estimated based on the number of diverted trips, choice of alternative transportation mode, trip lengths, and the number of passengers per vehicle. An increase of 230,000 daily VMT was estimated, which represents a 0.5 percent growth in the regional total.

The air quality impacts associated with the VMT changes were calculated using EPA emission factors from their MOBILE2 program. The estimated rates of increase in regional emissions are as follows:

Non methane HC	-	191.3 tons/year
Exhaust CO	-	2,929.2 tons/year
Exhaust NO_x	-	242.6 tons/year
Lead	-	4.7 tons/year

The air quality impacts of additional highway congestion resulting from diverted trips was then estimated. This analysis uses an expressway queuing model, developed by CTPS, that predicts delays based on daily traffic volumes relative to highway capacities at bottleneck points. The additional automobile trips to and from Boston were proportionally allocated to radial highways to produce predicted traffic volumes. The predicted increase in auto emissions was estimated using the EPA's MOBILE2 automobile emissions factors and queue speeds. Congestion conditions were found to lead to a greater increase in CO and HC emissions than would be anticipated based VMT changes alone, since CO and HC pollutant emission levels increase as vehicle speeds decrease.

The State Implementation Plan outlines the steps that the state will take over the next five years to attain Federal air quality standards. The increase in emissions resulting from the fare increase is estimated to be less than one-half of one percent of the reduction needed by the transportation sector to attain the standards. Presently, it is estimated that the state will attain these standards and provide an additional cushion to accommodate growth. Increased vehicle emissions resulting from the fare increase can be accommodated by this cushion; however, it will reduce the total growth potential allowable within the region.

An analysis of the change in CO concentration at intersections designated by the Massachusetts Department of Environmental Quality Engineering (DEQE) as CO Hot Spots was undertaken as part of this study. A CO Hot Spot is an intersection identified as having high concentrations of CO. The CO Hot Spot Analysis technique used was the EPA's Volume 9 method as modified by DEQE. (This technique considers traffic characteristics such as volumes, intersection configurations, signal timing and speeds as well as meteorological conditions such as wind speed, wind direction and dispersion rates.) None of the intersections were found to exceed the 1-hour standard. However, prior to the fare increase, the 8-hour standard was exceeded at two of the identified intersections. It is estimated that as a result of the fare increase, CO concentrations will increase at one of these intersections and that a third intersection will exceed the 8-hour standard.

Energy consumption impacts relating to the diversion of riders from transit to private automobiles occur on two levels. Initially, it is estimated that motor fuel consumption would increase by 4.6 million gallons/year due to additional VMT. Secondly, the anticipated increase in traffic congestion would cause an increase in fuel consumption of 689,000 gallons per year. The total additional fuel consumption of 5.4 million gallons per year represents one quarter of one percent of the annual motor fuel consumption in the state.

The overall energy efficiency of the MBTA itself, has been found to be increasing over the past few years. Energy efficiency measured in miles/gallon-equivalent has increased by approximately 20% while total consumption has been reduced by roughly 23%

1.1.7 Socioeconomic Impacts

A basic goal of a public transportation agency is to promote social and economic equity by providing mobility and equality of access to employment, health care, educational, cultural and shopping opportunities. The degree to which it meets this goal is largely determined by its fare and service levels. This section summarizes the impact of recent fare increases on the MBTA's ability to meet the needs of various groups of users.

As expected, the recent fare increases affected low-income riders to a greater extent than those with higher incomes. Depending on the mode used, an individual from a low-income household could spend between 3 and 7 percent of his household income on public transportation. This compares with between 1 and 2 percent for a person from an average income household. However, fewer low-income riders were lost, as compared with other groups, since they tend to have fewer alternative means of travel. As a result, they comprised a larger proportion of daily ridership.

A greater proportion of trips by low-income riders occur on buses and trolleys, as opposed to rapid transit. This would seem to explain the low fare elasticities exhibited by bus and trolley ridership relative to that of rapid transit.

Since 1979, trips made by children (5-11 years) and students have dropped by approximately 28 percent. During this period, non-school-related trips have experienced a proportionally greater decrease in ridership than school-related trips. This may be due to the fact that the MBTA presently allows children with badges to pay half fare for school trips. This subsidy of school trips presently costs the MBTA $2.8 million per year. In addition, communities such as Boston subsidize students who ride the MBTA by buying tokens and passes and distributing them to qualified students.

The Urban Mass Transportation Administration (UMTA) requires that transportation authorities receiving UMTA financial assistance make their facililties available to the elderly for no more than half the full fare during off-peak time periods. The MBTA presently provides free access for the elderly and handicapped between 9:30 AM and 4:00 PM, Monday through Friday. This program has been credited with mitigating some of the adverse effects on ridership of the fare increases. Since the institution of free fares, elderly and handicapped ridership has increased by approximately 13,000 riders per average weekday. The cost of this program to the MBTA is approximately $5.0 million more per year than if half-fares were charged at all times, assuming no ridership loss. (In December of 1982, this free fare for the elderly was ended and a ten cent all-day fare was instituted.)

Discretionary trips are generally more sensitive to changes in fare and service levels than are work or school trips. The discretionary rider has more of an opportunity to change the destination or mode of his trip. Fare and service changes between 1979 and 1981 have caused the number of discretionary trips to decline daily by 33,700 trips or approximately one-third. During this period, the number of daily shopping trips decreased by 16,700. Losses in sales for the entire period, as estimated by downtown merchants, totaled approximately $6 million. These sales are assumed to be shifted from the core to suburban shopping centers which are accessed by automobile.

This analysis has also developed a series of elasticities which were disaggregated by mode, time of day, user income level and trip purpose (specific to the MBTA). These could be used in the future to project the relative impacts of fare policy changes on various socioeconomic groups. In this manner, the MBTA might more closely gauge the revenue and ridership impacts of new fare policies.

1.2 MITIGATING MEASURES

The MBTA has implemented and is investigating measures which would lessen the adverse impacts of the fare increases and service reductions on the environment by encouraging mass transit usage. These measures support the MBTA policy of increasing riders while working to balance the overall financial burden among riders and public revenue sources.

Many of the mitigating measures suggested have a secondary impact on services and operations which, in turn, effect the ability of the MBTA to control costs and increase ridership.

A summary of mitigating measures identified in the conduct of this study and in the Management Practices Report is presented in Table 1-1. The summary presents a reference to the report text, a brief description of the measure and its status.

Type of Measure	Where Described In Report	Description of Measure	Status of Measure
Service			
1. Service Restoration	E.I.R p.52 153-155	The staged restoration of selected services during the summer and fall of 1981, as well as additional restoration during 1982.	Service has been restored on 23 routes and headway and trip time improvements have been made on most routes as of the spring of 1983.
2. Surface Traffic Improvements	E.I.R. p.156	The investigation of measures to improve the flow of surface vehicles, through bus lanes and signal preemption.	Various efforts to improve the flow of buses and surface rail vehicles are under consideration.
3. Service Quality Improvements	E.I.R. p.157	Service Quality Improvements Service quality improvements are being addressed through a multiplicity of ongoing programs.	
		A. Equipment Replacement and Restoration	
		1. Replacement of an average of approximately 100 buses each year to maintain an average fleet age of six years.	Bids are being sought for 20 articulated buses and consideration is being given to additional purchases.
		2. Acquisition of new cars for the Orange (120 cars) and Blue (70) lines is near completion. In addition, the purchase of between 50 and 60 Red Line cars is anticipated as needed, due to the extension of the Red Line to Alewife and increased ridership on the South Shore Line.	Acquisition of 120 Orange Line and 70 Blue Line cars is completed. The bid process for 58 Red Line cars is to start in the fall of 1983 with delivery scheduled for 1986.

SUMMARY TABLE OF MITIGATING MEASURES

TABLE 1-1

(CONT.)

1 OF 7

Type of Measure	Where Described In Report	Description of Measure	Status of Measure
3. Service Quality Improvements (cont.)	E.I.R. p.157-159	Included in this program are:	
		1. The installation of communication cable.	Will proceed concurrently with signal installation.
		2. The installation of an emergency telephone system.	Will proceed concurrently with signal installation.
		3. Computer-aided bus radio system.	Design funds sought for 1983. Installation expected in 1985.
		4. Completion of an MBTA/police radio system in the Authority's tunnels.	Currently begun, completion in 1984.
		D. Track and Structural Improvements	
		A multi-year track renovation program in which all deteriorated and substandard track on the Green Line and the three rapid transit lines will be renewed or replaced. Major track improvements are proposed on the following lines:	
		1. The Blue Line (Airport to Wonderland).	Project to be completed in 1983.
		2. Green Line rights-of-way and track bed rehabilitation.	Green Line (B) to be completed in 1983. Haymarket Portal to Park in 1984.
		E. Station Renovation Projects	
		A number of station modification and renovation projects have been proposed and are in various stages of planning and implementation. Among the projects currently being proposed are:	

TABLE 1-1

Type of Measure	Where Described In Report	Description of Measure	Status of Measure
3. Service Quality Improvements (cont.)	E.I.R. p.158, 159	1. Columbia Station.--Enlargement and renovation.	Construction scheduled for 1984-1985.
		2. Kendall Square.--Modernization, enlargement, and improvements to the station and platform.	Construction scheduled for 1984-1985.
		3. Platform lengthening to accommodate six-car trains at Washington, Park Street (Red Line portion), South Station, Central Square, Broadway, and on the Blue Line at the Suffolk Downs station.	Suffolk Downs construction in 1983. Central, Park, and Washington construction in 1984. Broadway and South Station in 1985.
		F. The Maintenance Program	
		A program to provide preventative maintenance and thus reduce operating costs, increase revenue, and productivity, and also improve safety and service quality. This program includes the provision of test equipment, shop tools, machinery, etc., as well as a sufficient quantity of spare replacement parts to maintain a high level of vehicle availability and regularly-scheduled inspections.	
		Collectively, the purpose of improvements such as these is to reduce the number of incidents of system failure and, thereby, improve reliability of the system.	

SUMMARY TABLE OF MITIGATING MEASURES

TABLE 1-1

(CONT.)

3 OF 7

Type of Measure	Where Described In Report	Description of Measure	Status of Measure
3. Service Quality Improvements (cont.)	E.I.R. P.157-159	3. Green Line LRV's are being slated for reconstruction, and general vehicle modifications are being made to insure the durability of the vehicles.	Ongoing project.
		4. Replacement and improvement of carhouses/garages/shops; a major upgrading of the existing facilities used to house and maintain the vehicle fleet.	Replacement facility for Reservoir Carhouse is under construction. Renovation of Quincy and Lynn Bus garages is scheduled to begin in 1983.
		B. Electrical Power Improvements	
		A major classification of renovation projects required to modernize and upgrade the present capabilities of the system. Parts of this project include:	
		1. Conversion from the obsolete 25Hz power system to a centrally-connected 50Hz system.	Completion by the end of 1984.
		2. Resectionalization of the AC/DC feeder cables between substations and tracks.	Design of this program is scheduled for implementation in 1983-1984.
		3. Power cable replacement of deteriorated cable ducts.	Currently is 20 percent. The remainder of the program is scheduled for completion in 1987-1988.
		C. Signals and Communication Improvements	
		A major program for the renewal or replacement of deteriorated or substandard signal equipment on the Red, Blue, and Green lines.	Red Line: Completion in 1984. Blue Line: Beginning in 1984. Green Line: Beginning in 1987.

Type of Measure	Where Described In Report	Description of Measure	Status of Measure
Planning			
1. Service Planning Staff Increases	M.P.S.* Touche-Ross p. 21, 22	Increase Service Planning group--three transit planners and five traffic checkers.	Currently in process.
2. Make Service Planning A Priority of All Managers	M.P.S. Appendix B Touche-Ross	Establish a Service Planning Committee of many managers to review service requests.	Was reactivated in May 1982.
3. Revision of 1977 Service Standards	M.P.S. Touche-Ross p. 21, 23	Update these standards to reflect current policy influences on the provision of services. The planning process itself should be reviewed in light of the revised service standards and should include the procedure and deadlines for new service requests.	Final report is scheduled for completion at the end of 1983.
4. Automation of Simple Service Planning Functions	M.P.S. Touche-Ross p. 24	Micro-computer acquisition and use by the service planning office to facilitate data management. Scheduling operations continue the transition from manual systems to automated systems.	A TRS-80 microcomputer was installed in 1983. Service Planning Staff is currently participating in an APTA-UMTA Productivity Program.
5. Improvement of the Planning Data Base	M.P.S. Touche-Ross p. 24	Internal and external data on traffic counts, passenger counts of other authorities, and school enrollments should be maintained for use by the Service Planning Staff.	The Central Transportation Planning Staff is establishing a staff support group for assistance in maintaining a comprehensive data base.
Efficiency			
1. Preventative Maintenance	M.P.S. Appendix A Touche-Ross p. 57	Preventative maintenance emphasis increased. Establishment of vehicle maintenance standards should be developed and closely adhered to.	A formal program of vehicle inspection has been established. A system of programmed maintenance and parts acquisition is scheduled to be in operation by the end of 1983.

*Management Practices Study.

SUMMARY TABLE OF MITIGATING MEASURES

TABLE 1-1

(CONT.)

5 OF 7

Type of Measure	Where Described In Report	Description of Measure	Status of Measure
1. Preventative Maintenance (cont.)	M.P.S. Appendix A Touche-Ross p. 57	Quality control function for preventative maintenance.	The system is scheduled to be in operation by the end of 1983.
2. Fuel Consumption Review	M.P.S Appendix A Touche-Ross p. 58	An energy review and monitoring of MBTA rapid rail fuel consumption.	A new monitoring system will be complete by 1984.
Management			
1. Management Rights	E.I.R. p.161 Appendix D	Effect more efficient, productive operations through the passage of management rights provisions of Chapter 581 of the Acts of 1980.	Measure was passed in 1981 and additional actions continue to be added.
2. Increased Emphasis on Management Information Systems	M.P.S. p. 3	Upgrading of the Management of Information Systems to the status of a Directorate.	In 1982 this occurred.
3. Ridership Information Collection	E.I.R. p.162 Appendix A-5	Improved data collection procedures:	
		1. Evaluation of the SENTRY project for use.	Completion in late 1983.
		2. Continue with the annual (November) sampling program.	Occurred in 1982 and is planned for continuation on an annual basis.
4. Performance Evaluation System	M.P.S. Appendix A Appendix A p. 56	Development and systematic use of performance standards for evaluating the quality of service provision.	Has been instituted and is being refined.
5. Management Practices Study	E.I.R. p.162	A study of management practices that "outlines more efficient management procedures."	This was completed on October 29, 1982.

Type of Measure	Where Described In Report	Description of Measure	Status of Measure
6. Operator Work Rules	M.P.S. Appendix B Touche-Ross p. 25	Operator work rule changes should be implemented, including:	
		1. Reducing the number of operator picks to three annually.	Are being addressed by the Transportation Management Improvement Plan Task Force.
		2. Assigning "extra" work trips on a volunteer basis.	
		3. Greater flexibility in assigning cover personnel.	
7. Productivity Measurement	E.I.R. p.379	Improved Productivity Measurement Programs and their coordination to insure an ability to monitor progress.	
8. Manager Evaluation Process	M.P.S. Appendix C Touche-Ross P. 17	Improve manager evaluation process to be more goal oriented and performance based:	All four operations departments will have their performance indicators finalyzed by mid-1983.
		1. Give the personnel department monitoring responsibility.	This has been done.
		2. Establish a probation policy.	
		3. Establish a Bonus/Incentive Program.	
		4. Train the managers to establish objectives and evaluate employees against those objectives.	Top executives have attended training session in implementing the evaluation process.
9. Maintenance Staff	M.P.S. Appendix A Touche-Ross P. 57	Maintenance staffing mix should be adjusted. More different levels of mechanics and repair staff should be established, and lower level functions should be contracted to outside contractors.	30 new third class mechanics have been hired and 9 more are to be hired by the fall of 1983. First and second class mechanics have been reassigned to do maintenance and repair work.

SUMMARY TABLE OF MITIGATING MEASURES

TABLE 1-1

(CONT.)
7 OF 7

1.3 FINDINGS AND RECOMMENDATIONS

Transit fares were increased in 1981 to increase the fare-revenue element of the MBTA's funding schedule for providing sufficient funds to cover the cost of the MBTA's annual budget. This report assesses the impact of the fare increase with respect to goals of maximizing transit ridership and improving the environment.

1.3.1 FINDINGS

In the course of preparing the Environmental and Socioeconomic Impact Report, a number of findings have been made. These findings include both impacts of the fare increase and opportunities identified in various areas of MBTA operations, service provision, or management to provide mitigating measures to such impacts.

1.3.1.1 Impacts

The primary objective of the MBTA fare increase was to raise sufficient funds through user charges to retain adequate service levels and to be in compliance with the expressed goal of reducing public sector reliance on local taxes. The objective was to accomplish this with a minimum of adverse impact on environmental quality, energy consumption, and social equity. The primary indicators that were chosen as a measure of whether the objectives of the fare increase were being realized were actual levels of revenue and ridership compared with predicted levels.

Measurements and analysis of the impacts of the 1981 fare increase have occurred concurrently with both the fare increase and the subsequent decrease in fare levels. This timing has allowed for some of the new ridership (post-increase) estimates to be derived as the result of a direct fare mix sampling study conducted in November, 1981.

It should be noted that this approach is somewhat unusual in that ordinarily an Environmental Impact Report (EIR) would contain predictive information on ridership and environmental quality in advance of the implementation of the program. Thus, no actual data on ridership change usually accompanies the EIR.

Environmental data provided is solely from modeling efforts and does not include any sampling or data collection performed after the fare increase was instituted.

Impacts of the 1981 fare increase are described in detail in the body of the report. Some of the more notable impacts have been grouped into four categories--revenue, ridership, environment and energy--and are described below.

A. Revenue

Before the fare increase was instituted, a package of fare and zonal changes had been proposed and was calculated to have a potential of increasing revenue by $24.4 million. This fare change package was never implemented and was altered to mitigate the impacts on special groups which would have been adversely affected by uniform fare change. The package differed from the implemented fare increase in that it had a different timing for pass price increases, different rapid rail fare zones, fares for the elderly and other changes from the implemented fare increase. As instituted, the 1981 fare increase was anticipated to produce $17 million in increased revenue in 1981.

- The 1981 revenue generated from the fare increase, as adjusted for service-related impacts, has been estimated at approximately $13.6 million.

- The 1981 revenue generated from the fare increase, as adjusted for service-related impacts, has been estimated at $13.6 million ($9.5 million net increase in revenue plus $4.1 million in service-related revenue losses).

- The principal reason for the difference between the actual and projected revenue increases was limitations in the MBTA's revenue/ridership data base and associated errors in estimation.

- Revenue lost to the MBTA as a result of reduced fare programs for children, students, elderly and the handicapped is an estimated $15.2 million per year, or 19% of annual fare revenue.

B. Ridership

- A comparison of November, 1980 to November, 1981 ridership levels indicates that approximately 90,000 fewer trips were made on an average weekday. This translates into a loss of roughly 15.0 percent of the average weekday trips made on the MBTA. Of the 90,000 trips, it is estimated that approximately 57,000 fewer trips (9.4 percent) were made because of the fare increase of August, 1981. Service cuts accounted for an estimated loss of 32,000 trips (5.3 percent) on an average weekday.

- There was an estimated increase of 35.8 percent (16,600) in daily transit trips by the elderly.

- Also, there was a ridership decline in the student and children category of an estimated 24.4 percent, a 14,500 decrease in the number of daily trips by this group.

- The method of fare payment that riders chose shifted as pass discounts became more attractive. This was demonstrated by a 15 percent increase in the use of prepaid passes.

- With the exception of the elderly and handicapped fare groups, the fare increase has tended to have a greater economic effect on those who are transit dependent and especially persons of low income. Riders from low-income households were estimated to be spending an average of 4.2 percent of household income on transit fares before the 1981 fare increase, and 6.5 percent after the increase. This compares with 1.5 and 2.3 percent, respectively, for average income households. The fare increase thus had a greater impact (2.3% of house-hold income) on the low-income user than the average-income user (0.8%). In addition, fewer trips were lost from the low-income group of users as compared to other groups, as they tend to have fewer alternative travel choices.

- For each user category in which the fare was increased, the change resulted in a net increase in fare revenue. That is, after adjusting for ridership loss or increase, the fare increase always resulted in an increase in revenue to the MBTA. Fare reductions for each user category always resulted in a net revenue loss.

C. Environmental Quality

As the cost of public transportation increases and travelers use transit less, a portion of the trips previously made by transit will be made by another transportation mode. If passengers switch to either private automobiles or taxi services, the total number of vehicle miles traveled (VMT) will increase.

As a result of this increase in vehicle miles traveled, pollutant emission levels and energy consumption levels will rise. In addition, added traffic congestion will produce a further increase in both emissions and energy consumption.

- Based on the estimated increases in VMT and congestion resulting from the 1980 and 1981 fare increase, non-methane hydrocarbon emissions, which may be used as a general air quality indicator, are estimated to have increased by 191.3 tons/year (476 kg/day) in the region. Of this amount, approximately 105 to 125 tons per year can be attributed to the 1981 fare increase. Other emissions, including oxides of nitrogen and lead, are also expected to have risen on the regional level.

- Carbon monoxide (CO) is a localized emission problem for which 1-hour and 8-hour standards exist. The fare increase is estimated to cause exceedance of the 8-hour standard at one intersection and further exceedance of the standard at a second intersection.

- To achieve the air quality standard for non-methane organic compounds (NMOC) by 1987 requires a reduction of 35% in NMOC emissions. Programmed activities including Federal motor vehicle emission controls, state motor vehicle inspection and maintenance programs, and control of point source emissions will reduce NMOC emissions by 41%, 6% below the standard. Increased emissions associated with the fare increase will increase NMOC emissions by 0.189%.

- The 1982 Transportation Element of the State Implementation Plan for the Boston Region provides an analysis of the reasonably available control measures (RACM's) and programs adopted for implementation since 1979. The sum of these emission reductions which are needed for the Boston region to achieve its yearly air quality attainment goal for 1982 are estimated to be directly off set by the emissions associated with the 1981 fare increase. In order to attain these goals, it would become necessary to implement all of the adopted RACMs. This would leave no additional margin for any unexpected increases in emissions. Furthermore, the region's commitment to achievement of "reasonable further progress" towards the mandated 1987 attainment goals will be adversely affected.

D. Energy

- A 10 percent decrease in ridership, without changes in service levels, has no significant impact on levels of energy consumed by the MBTA.

- Overall, the MBTA has succeeded in improving its energy efficiency during the period of ridership loss.

- Between 1980 and 1981, the diversion of riders from public transportation to automobiles increased motor fuel consumption by an estimated 4.7 million gallons per year. Of this amount, approximately 1.9 million gallons can be attributed to the 1981 fare increase.

- In addition, 689,000 gallons per year is estimated to be required in fuel consumption which would occur due to roadway congestion resulting from the fare increase.

- Total additional consumption of approximately 5.4 million gallons per year represents one quarter of one percent of the annual motor fuel consumption in the state.

1.3.1.2 Problem Identification

A. Institutional

- The Regulations of the Executive Office of Environmental Affairs (EOEA), as adopted in accordance with the Massachusetts Environmental Protection Act, require that an Environmental Notification Form be filed with EOEA prior to implementation of a fare increase of more than 30 percent. The filing of said "Notice" is the initial step in an eleven-step environmental process. This process can be very time consuming, thereby precluding MBTA management from adjusting transit pricing in a timely manner. (In this instance, the environmental process has taken over one year. The actual fare increase was expedited by the granting by EOEA of permission to prepare a "Generic" Environmental Impact Report after the fare increase was implemented.) Compliance with the Regulations, by virtue of the time requirements, limits MBTA management in instituting a fare increase.

- Also, the MBTA's enabling act (Chapter 161A of the Massachusetts General Laws) provides that local transit fares cannot be altered without prior approval of the MBTA's Advisory Board. This places an additional time constraint on adjusting fares.

B. Data and Revenue Collection

As stated previously, the EOEA agreed to waive the conventional environmental impact review process. The Authority agreed to prepare a "Generic Environmental Impact Report" after the fare increase was implemented so as to measure the actual impacts of the fare increase. Specifically, ridership levels were agreed to be a useful indicator of significant impacts of the fare increase. There were, however, major difficulties found in attempting to determine the ridership impacts, as there were difficulties in establishing an adequate ridership/fare baseline for previous years.

To help gather current data, the MBTA, with the assistance of the Central Transportation Planning Staff

(CTPS), designed and implemented a Ridership and Fare Mix Sampling Program with the primary purpose of estimating ridership by fare category. This program was conducted during November, 1981, to comply with the EOEA/MBTA agreement which required that November, 1981 ridership be compared with November, 1980 ridership. The results of this survey appear to provide a reasonable estimation for the average weekday ridership during November, 1981. Unfortunately, no similar data base was available for November, 1980. As a result, the Authority was concerned with comparability of data. Creation of a comparable data base for 1980 was based on solid data where it was available and beyond that is based on a series of assumptions. Although these assumptions appeared reasonable when viewed independently, they do introduce a degree of uncertainty into the calculations.

Furthermore, the collection of usable and comparable revenue data for rapid transit and surface routes has been marked by a variety of data collection and reliability problems. Problems associated with monitoring the access at rapid transit stations hindered the data collection activities and included malfunctioning turnstiles and passreaders and the authorized and unauthorized use of gates. Because of the malfunctioning equipment, not all passengers using turnstiles were properly recorded by the meters. Authorized use of gates presented the necessity to perform special passenger counts while unauthorized use of gates permitted passengers to enter the platform areas unrecorded. In some instances, corrective factors were applied to the survey data to compensate for this problem. Yet, in all likelihood, this segment of ridership was undercounted. Generally, all revenue data available has tended to be somewhat inaccurate due to such counting factors.

Furthermore, data on ridership characteristics, notably socioeconomic characteristics has not been systematically maintained and, thus, must be derived from passenger profiles which may not reflect the current situation.

The confidence level for the 1981 ridership estimate is relatively high, especially for the measurements which resulted directly from the November, 1981 Ridership and Fare Mix Survey. The method used for estimation of 1980 ridership, however, is marked by uncertainty.

- The absence of a reliable data base prior to 1981 hampered efforts to estimate the impacts of the fare increase on revenue and ridership both before and after the fare increase was implemented.

- Open gates and their use creates potential for fare avoidance and makes ridership estimation and revenue control difficult.

- Malfunctioning turnstiles and passreaders create problems for both ridership estimation and revenue control.

C. Impact Assessment

The assessment of the environmental, energy and socioeconomic impacts principally used the results of the ridership survey for base data. The impacts were derived by assessing how the changes in ridership would create a variety of associated impacts. Interpretation of these results is difficult due to the uncertainty of the base data, and due to the purposes and typical applications of the modeling techniques. Modeling techniques were used particularly for the air quality impacts: no air quality sampling programs were initiated. Models were employed to estimate emission levels of various air pollutants.

An additional problem was the difficulty in estimating the traffic diversions due to the 1981 fare increase. The traffic diversion assumed in the study is that resulting from the combined effect of the 1980 and 1981 fare increases. The impacts of the 1981 fare increase, the subject of the study, are not independently estimated or sampled.

- Low cost techniques currently available for estimating air quality impacts which can be applied in a short time period produce results of limited accuracy.

1.3.2 RECOMMENDATIONS

Recommendations are made in five areas:

- Institutional, which addresses the manner in which future fare increases should be considered.
- Fare structure, which addresses considerations for future fare adjustments.
- Revenue collection, which addresses the manner in which revenue is collected.
- Management and Systems Efficiency, which addresses the efficiency of the system and its management.
- Data collection, which considers the data base necessary to estimate ridership and revenue reliably and to assess their impacts.

1.3.2.1 Institutional

To avoid institutional delays in implementing fare increases and to avoid the potential for acute impacts on the environment, it is recommended that:

- o An MBTA Fare Committee be reestablished to develop fare policy recommendations and oversee their implementation.
- o A policy be adopted establishing a fare revenue goal as a percentage of the annual expense of operating MBTA services (such as 30%) exclusive of fixed charges and private carrier subsidies.
- o Fare revenue goals be reviewed annually and fare schedules adjusted, as appropriate, in conjunction with the MBTA's annual budget development process, commencing with the fiscal year 1985 budget.
- o Proposed fare adjustments be developed early in the MBTA budget process so as to permit updating of the Environmental Impact Report (if necessary) prior to implementation of the action.
- o The Environmental Impact Report (EIS) be updated in the event of a fare increase or an annual reduction in vehicle miles of scheduled service of greater than 10%.
- o The EIR update should address fare and/or service change impacts on transit ridership and, in turn, on energy use, air pollution, and traffic and on measures to mitigate any adverse impacts on the environment.
- o The data base and methodologies utilized in preparation of this document are modified to improve accuracy and/or reduce the work effort to be applied in updating the EIR.
- o Data bases for making decisions and preparing impact analyses be maintained.

1.3.2.2 Fare Structure

In the event of future fare adjustments, it is recommended that the following be considered:

- o The basic zone fare system adopted in 1981 be retained.
- o Since fare reductions will result in reductions in total revenues, fare decreases be avoided.
- o Proposed fare reductions be accompanied by the identification of alternative funding.

- Future fare adjustments minimize the impact of increases upon riders by minimizing increases for short trips, especially those requiring transfers.

- The fare program for handicapped persons be reviewed to assess the potential for simplifying the fare schedule through establishing a common fare for both elderly and handicapped persons and to assess the effectiveness of program eligibility requirements.

1.3.2.3 Revenue Collection

- To minimize potential for fare evasion, it is recommended that control of station entry and exit be tightened by securing all gates which are not under the direct control of MBTA personnel and by assuring that all gate locks which are remotely controlled by collectors are secure and in good operating condition.

- To permit more flexible fare schedules in the long-term, it is recommended that the Pass Program be advanced as follows:

  - The actions necessary to sustain a high percentage of operable pass reader equipment be advanced.

  - Upon achieving reliable pass reader equipment operation, that the expansion of the pass reader program be advanced.

  - The potential for selling passes from collector's booths at the busier transit stations at the end of each month be explored.

- To reduce lines of token purchasers, it is recommended that:

  - The potential for reassignment of gatemen as collectors at stations, for time periods in which lines are longest, be explored.

  - The option of selling tokens in bulk at a reduced price be further pursued.

1.3.2.4 Data Collection and Service Planning

To provide reliable estimates of ridership as required to track system performance and project ridership and revenue, it is recommended that:

- The Ridership and Fare Mix Survey conducted in November 1981 be repeated on an annual basis. The objectives to be met are:

  1. To estimate ridership based on currently collected revenue data.

2. To incorporate Section 15 reporting requirements to the extent that it is practical to do so.
3. To enhance the survey technique and to evaluate it along with alternative programs for estimating ridership.
4. Where practical, to construct a ridership data base which improves the socioeconomic data currently available for conducting impact analysis.

- Fare collection equipment be monitored and maintained to assure reliable operation and accurate readings.
- Revenue and ridership reports generated from fare collection equipment readings be produced in a timely manner.
- The SENTRY project be evaluated for standard use in data collection and monitoring.
- Simple service planning functions be automated to enhance the capability of the MBTA Service Planning Office for additional functions.

2.0 EXISTING CONDITIONS

2.1 ADMINISTRATIVE STRUCTURE

The MBTA was formed under Chapter 563 of the Acts of 1964, which abolished the Metropolitan Transit Authority and assigned its functions and equipment to the MBTA. The MBTA district includes the original 14 cities and towns in the MTA district and was expanded to include 79 cities and towns in the Boston metropolitan area. This area is shown in Figure 2-1.

Since 1964, two reorganization bills have been approved that change the administrative structure of the MBTA.* The MBTA is currently controlled by a seven member Board of Directors; the Secretary of Transportation is Chairman of the Board. A General Manager controls the day-to-day operations of the MBTA. The MBTA Advisory Board, composed of local officials representing the towns in the district, reviews and approves the annual operating budget.

2.2 DESCRIPTION OF THE EXISTING SYSTEM

The MBTA currently provides rapid transit, light rail, trackless trolley, bus, and commuter rail services throughout the Boston metropolitan area. The distinctions between different types of transit are described in Table 2-1.

2.2.1 Commuter Rail Transit

The commuter rail network is composed of the Northern and Southern Divisions, each of which consists of four routes. The rolling stock for the northern routes was acquired from the Boston and Maine Corporation in late 1976; the rolling stock for the southern routes was acquired from Consolidated Rail Corporation, also in 1976. The B&M currently operates both divisions for the MBTA. Fares on the commuter rail system are zoned and range from $1.25 to $4.50. Transfer from the commuter rail to the rapid rail system is possible at both North and South Stations. As shown in Figure 2-2, parking is provided at most commuter rail stations.

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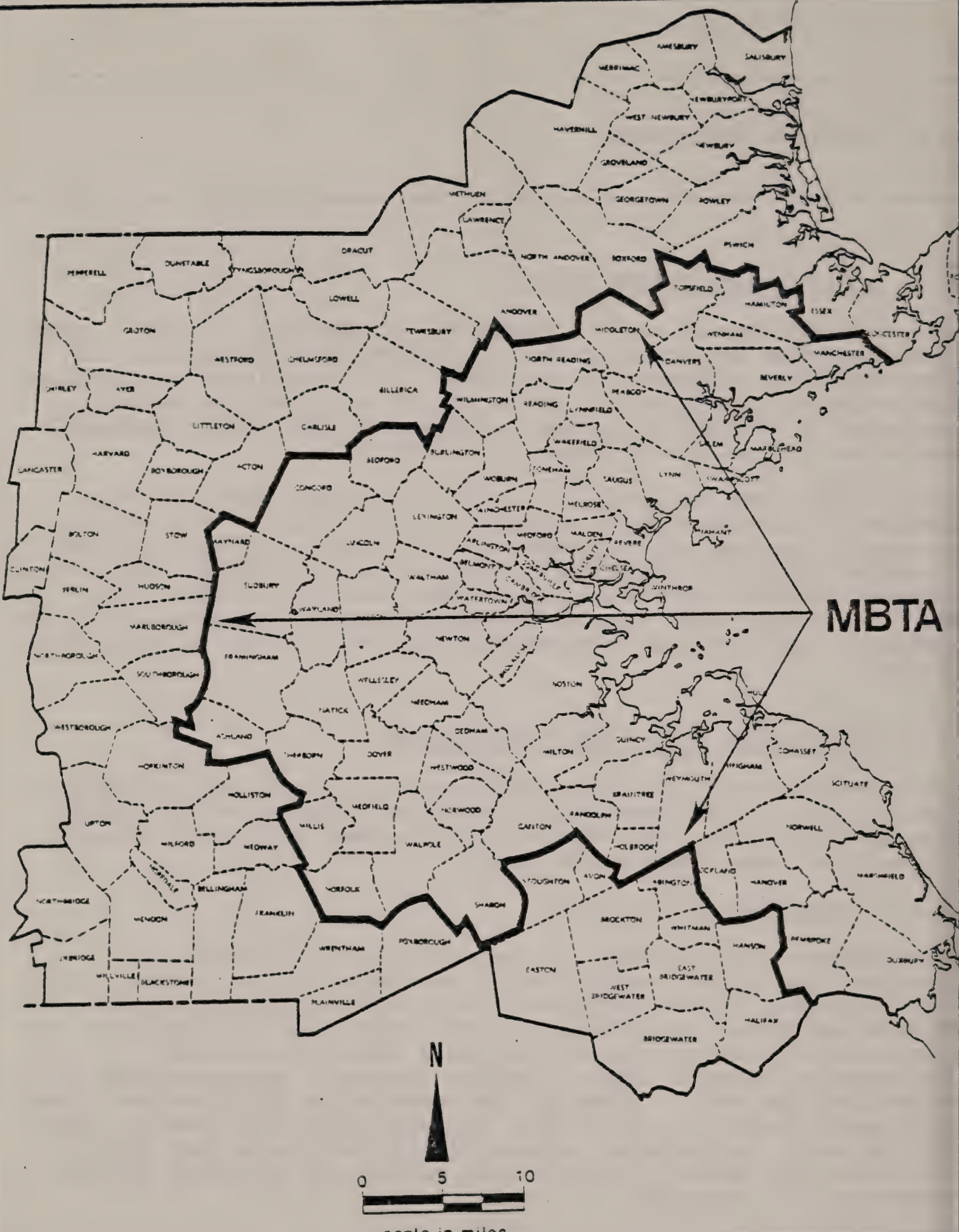
*Appendix A-5 includes a brief description of these changes.



THE MBTA DISTRICT

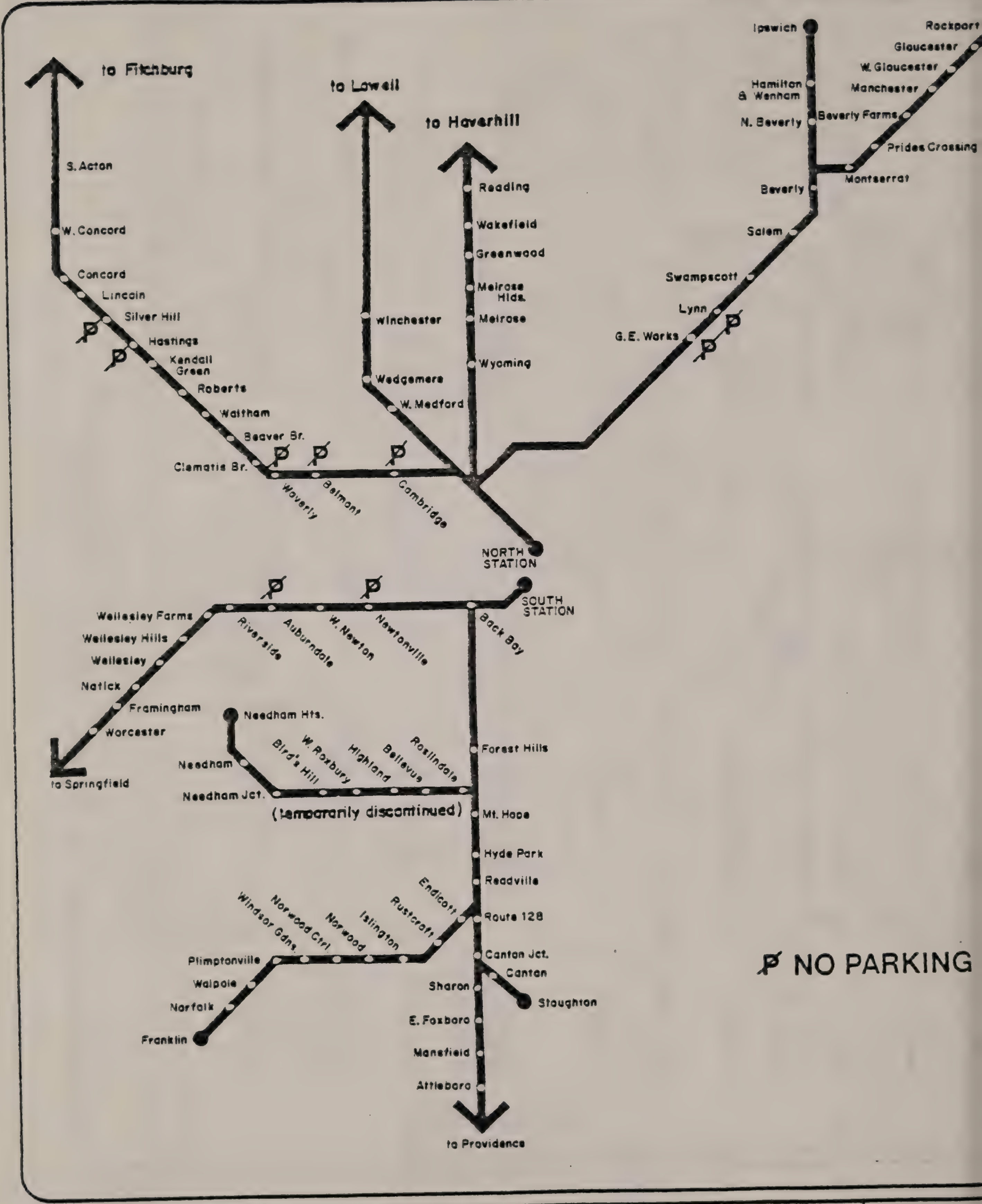
FIGUR

2-1

	Commuter Rail	Rapid Rail Transit	Light Rail Transit	Trackless Trolley	Bus
right-of-way	exclusive	exclusive	exclusive, street median, and mixed	non-exclusive	non-exclusive
grade crossings	few	none	many	n/applicable	n/applicable
grade	frequently at-grade	grade-separated	grade-separated and occasionally at grade	on-street	on-street
entry	mixed	high platform	low or no platform	on street	on street
stops (spacing)	more than one mile	1/4 - 1 1/2 miles	1/4 mile - 1/5 mile	1/8 - 1/10 mile	1/8 - 1/10 mile (local)
speed	30 mph+	15-25 mph	8-15 mph	10-15 mph	10-15 mph
consists of	commonly multi-car 4 cars+	usually multi-car 2-5 cars	one to 3 cars	bus-sized adapted vehicle	common bus
fare collection type	pre-paid	pre-paid	pre-paid and on-board collection	on-board collection	on-board collection
vehicles	range of typical rail cars	range of typical subway cars	PCC and LRV	usually bus-type trolleys	range of buses
power	diesel	electric, 3rd rail	electric, overhead lines	electric, overhead lines	diesel engines
stop configuration	on-line	on-line	on-line	on-line	off-line

TABLE 2-1

DESCRIPTION OF TYPES OF TRANSIT PROVIDED BY THE MBTA



COMMUTER RAIL NETWORK

Figur
2-2

2.2.2 Rapid Rail Transit

A map of rail transit services is shown in Figure 2-3. Major transfer points between modes are displayed in this figure as well.

The MBTA operates 344 rapid rail vehicles over three separate lines. The Red Line extends from Harvard Square in Cambridge through downtown Boston to Columbia Station in South Boston. At that point, it divides into two branches; one that continues through Quincy to Braintree and one that terminates in Dorchester. The Orange Line extends from Forest Hills Station in Jamaica Plain through Roxbury and the South End, to downtown Boston. It then continues northward through Charlestown and Medford into Malden. The MBTA's Blue Line originates at Wonderland Station in Revere and travels through East Boston into downtown Boston. Free transfers between lines are provided at six downtown Boston stations. These are shown in Figure 2-3.

Two major projects are currently being undertaken to improve the rapid rail system. The Southwest Corridor Project involves the relocation of the Orange Line south of Essex Station to a railroad right-of-way west of the existing elevated line. This segment will be approximately 4.7 miles long with eight new stations. The line will share the right-of-way with long-distance commuter rail services, which will also use three of the eight stations.

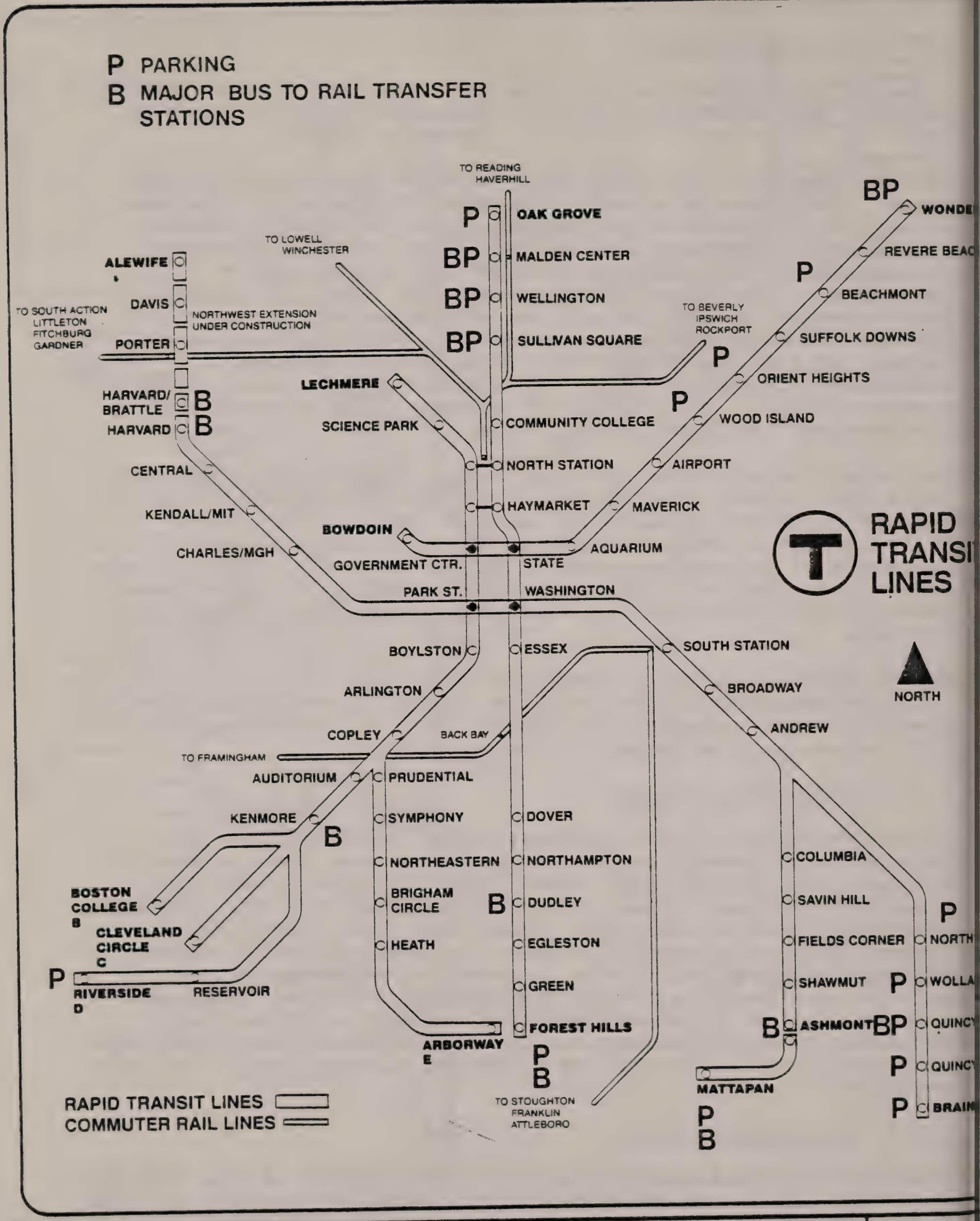
The Northwest Extension Project involves the construction of a 3.2 mile extension of the Red Line between Harvard Square and Alewife. This segment will contain three new stations, with a 2,000 space parking garage at the terminus.

2.2.3 Light Rail Service

The MBTA provides light rail service on the Green Line and Mattapan High Speed Line. The Green Line runs from Lechmere Station in East Cambridge through downtown Boston where it branches into four lines. The Arborway line runs from Copley Square to Jamaica Plain; the other three lines carry passengers between Kenmore Square and either Riverside or Boston College in Newton, and Cleveland Circle in Brighton. Service on the Mattapan trolley line, which runs between Mattapan Square and Ashmont Station in Dorchester, was restored in January 1981 following track improvements. The MBTA operates 339 light rail vehicles of which 209 are the older PCC variety and 130 are the new LRVs.

2.2.4 Trackless Trolley

There are 50 trackless trolleys used principally in the city of Cambridge and in the Watertown/Belmont area for weekday service. These vehicles travel at street grade and follow electrified



M.B.T.A. Rapid Transit Network (1982)

Figu

2-3

overhead lines. They operate much the same as buses, although they are slightly less flexible in routing due to their defined energy requirements.

2.2.5 Bus Transit System

The bus system operates out of nine garages spread throughout the MBTA region (Figure 2-4). Bus routes are expected to fill one or more of the following service functions:

- Linehaul - Direct travel over distances greater than two miles between a residential area and an activity center.
- Feeder/Distributor - Access to and from a service providing linehaul bus, rapid transit, streetcar, or commuter rail service.
- Crosstown - Connects either community subcenters or radial linehaul services.
- Inter-City - Travel between cities or towns, primarily in suburban areas.

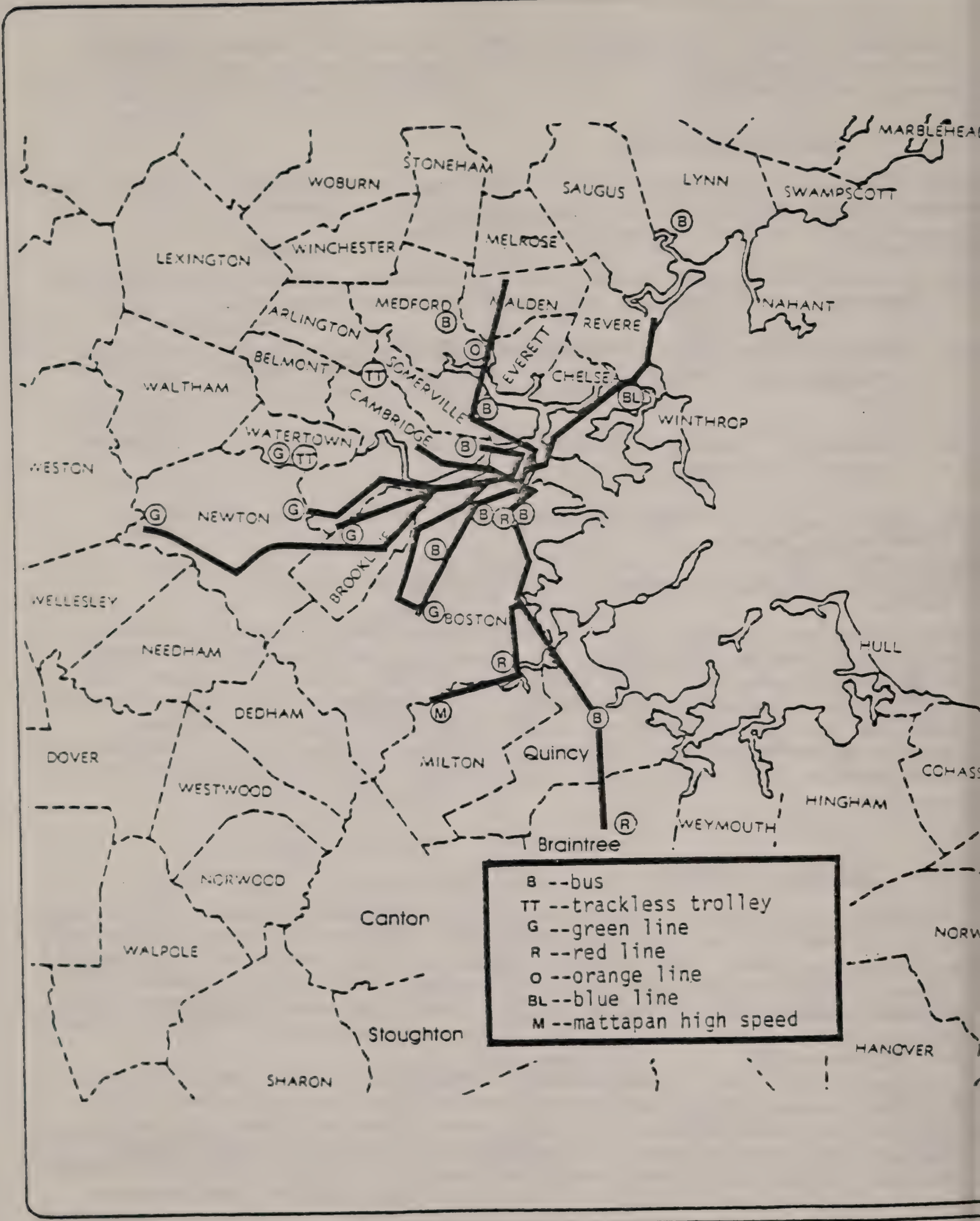
Major bus-to-rail connections are noted in Figure 2-3.

Bus fares are zoned with a 50 cent base fare on local buses for six miles and an additional 25 cents for each additional three-mile zone traversed. The MBTA owns 1,213 buses, of which 1,023 are actively used in operations. The number of vehicles, average vehicle age, and number of routes based at each garage are displayed in Table 2-2 (A and B). These tables also provide this information for rapid-rail, light-rail, and trackless-trolley services.

2.3 RIDERSHIP TRENDS

The MBTA's ridership levels were approximately 511,000 trips per average weekday in November 1981 for the rapid transit, bus, and trolley systems. The commuter rail service accounts for an additional 35,000 trips per average weekday. Historic ridership levels are listed in Table 2-3 and are displayed graphically in Figure 2-5 so that major trends can be observed.

In evaluating this information, it is critical to note that the values presented are estimates which have been produced from a variety of data sources. In the past, the MBTA has not maintained systemwide counts of passengers riding the vehicles. Rather, ridership counts were derived by taking a total of revenue collected and dividing this by an estimate of the average fare paid by each rider. Using this method, it becomes essential to use an accurate average fare value and the calculation of such



MBTA BUS GARAGES AND RAIL VEHICLE YARDS

Figure 2-4

MBTA Vehicle Assignments (as of April 1, 1981)

Mode Type	Garage/Storage Facility	No. of Vehicles	Average Age In Yrs.	No. of Based Routes	Vehicles Required In AM Peak	Average No. Vehicles Available AM Peak[1]	Average No. Vehicles Shortage in AM Peak
Bus	Albany Street[2]	130	3.7	16	112	112	0
Bus	Arborway	182	7.0	23	146	141	5
Bus	Cabot	194	8.6	22	127	112	15
Bus	Charlestown & Bennett	207	7.8	22	183	164	19
Bus	Eagle Street[3]	61	4.9	10	37	37	0
Bus	Fellsway[2]	75	15.3	11	65	65	0
Bus	Lynn	87	9.6	22	67	67	0
Bus	Quincy	87	8.5	16	73	73	0
	SUBTOTAL	1,023	7.9	142	810	771	39
Rail	Green Line	306	18.2	4	110	130	0
Rail	Orange Line	88	11.5	1	64	78	0
Rail	Red Line	164	14.1	2	104	108	0
Rail	Blue Line	92	18.7	1	40	57	0
	Trackless Trolley[4]	50	4.0	3	19	50	0

Source: MBTA, Title VI - Assessment for Capital and Operating Assistance, August 1981, and MBTA Bus and Rapid Transit Service Reports.

[1] Averages are for the first three days of the month. Service and schedule changes were instituted on April 4.

[2] Vehicles are operated out of Albany Street and Fellsway only during weekdays. Evening, weekend, and holiday service is provided for Albany-served routes by the Cabot Garage, and Fellsway-served routes by the Charlestown Garage.

[3] Eagle Street was closed on April 4, 1981, with vehicles reassigned to Charlestown and Lynn.

[4] Vehicles are operated only during weekdays.

Note: Vehicles available reflect the number of vehicles that are available at the beginning of the three hour peak period. They do not reflect vehicles that cannot be used during the entire period because of malfunctions.

MBTA Vehicle Assignments (as of April 1, 1981)

TABLE

2-2 (A)

MBTA Vehicle Assignments for Rating Period Beginning on April 4, 1981
(after spring service adjustments)

Mode Type	Garage/Storage Facility	No. of Vehicles	Vehicles Required In AM Peak	Average No. Vehicles Available AM Peak[1]	Average No. Vehicles Shortage in AM Peak
Bus	Albany Street[2]	130	89	89	0
Bus	Arborway	186	124	124	0
Bus	Cabot	199	98	98	0
Bus	Charlestown & Bennett	227	179	178	1
Bus	Fellsway	87	57	57	0
Bus	Lynn	97	81	80	1
Bus	Quincy	99	70	70	0
	SUBTOTAL	1,025	698	696	2
Rail	Green Line	166	98	127	0
Rail	Orange Line	88	64	78	0
Rail	Red Line	164	104	98	6
Rail	Blue Line	70	40	57	0
	Trackless Trolley[3]	50	19	50	0

Source: MBTA Bus and Rapid Transit Service Reports.

[1] Average number of vehicles available on weekdays during the month of April 1981 (excluding the 1st and 3rd of the month which was part of another rating period).

[2] Vehicles are operated out of Albany Street and Fellsway only during weekdays. Evening, weekend, and holiday service is provided for Albany-served routes by the Cabot Garage, and Fellsway-served routes by the Charlestown Garage.

[3] Vehicles operated only during weekdays.

TABLE

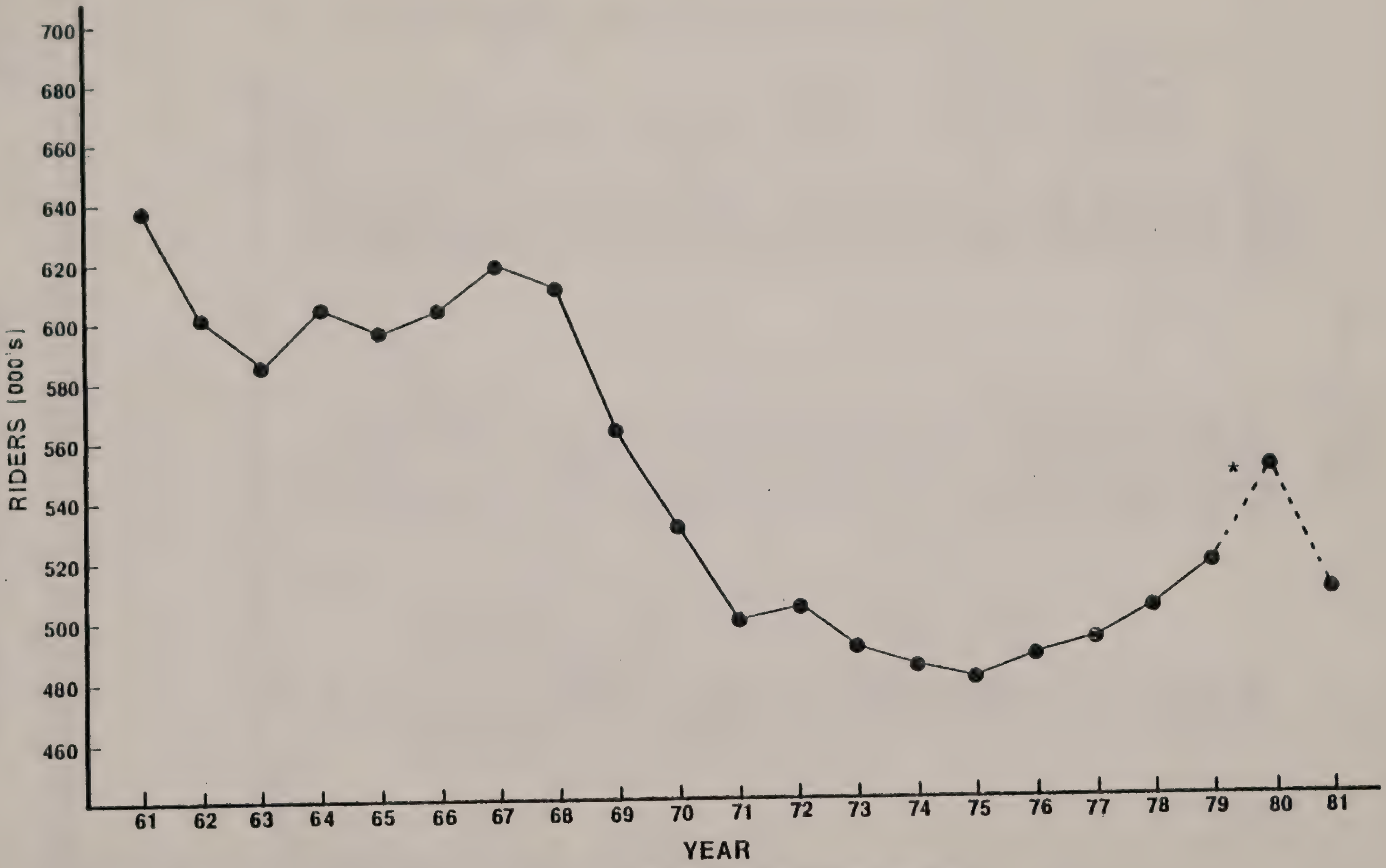
Ridership Levels on the MBTA
(1951-1981)

Year	Annual Ridership	Annual Average Weekday Ridership
1951	289,000,000	966,000
1952	278,000,000	930,000
1953	268,000,000	896,000
1954	244,000,000	816,000
1955	225,000,000	753,000
1956	219,000,000	732,000
1957	212,000,000	709,000
1958	206,000,000	689,000
1959	202,000,000	676,000
1960	200,000,000	669,000
1961	190,000,000	636,000
1962	180,000,000	602,000
1963	175,000,000	585,000
1964	181,000,000	605,000
1965	178,000,000	595,000
1966	181,000,000	605,000
1967	185,000,000	619,000
1968	183,000,000	612,000
1969	168,000,000	562,000
1970	158,000,000	528,000
1971	149,000,000	500,000
1972	150,000,000	503,000
1973	146,000,000	489,000
1974	144,500,000	483,000
1975	143,500,000	480,000
1976	145,700,000	487,000
1977	146,700,000	491,000
1978	151,400,000	506,000
1979	155,600,000	520,000
1980*	163,450,000	545,000
1981*	153,260,000	511,000

SOURCE: MBTA
*Not directly comparable because derived using a different method.

Ridership Levels on the MBTA
(1951-1981)

TABLE 2-3



*Not directly comparable; derived using different method.

FIGURE 2-5

a value may be derived in several ways. The figures presented in Table 2-3 give an indication of trends in ridership derived in this manner over the last 30 years.

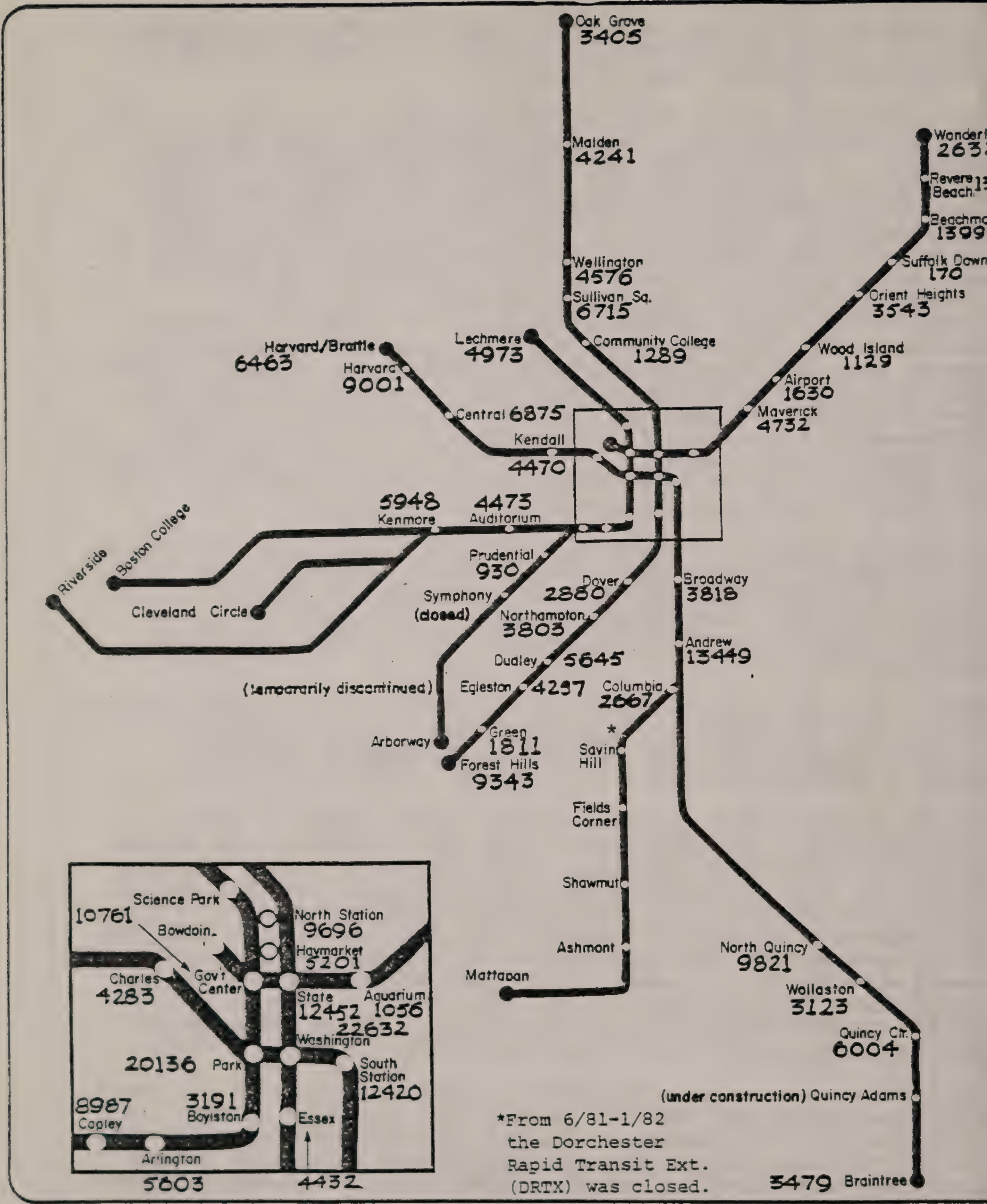
With the fare changes made in 1980 and 1981, it was felt that the mix of rider types and, thus, the average fare value may have changed. It was assumed that the ridership response of those paying lower fares, i.e., the elderly, would cause the average fare to be substantially lower than one might expect from the corresponding increase in the fare. In an attempt to correct for this, the 1980 ridership estimates have been derived by using all available revenue sources and making adjustments based on the number of linked and unlinked trips found in the 1978 Wilbur-Smith Survey of MBTA ridership. As a result, ridership estimates for 1980 are not directly comparable to previous estimates, due to changes in estimation techniques. In 1981, a fare-mix sampling program was initiated by the MBTA to estimate the new fare mix which occurred as a result of the fare increase. This sampling program and its results will be presented in a further discussion of ridership estimation and the steps the MBTA is taking to improve these estimates provided in Appendix B and in Section 7.1.2 concerning mitigating measures.

Ridership on public transportation in the Boston area has dropped significantly over the past three decades, declining from almost one million trips per day in 1950 to approximately one half that amount in 1982. Ridership declined steadily until the early 1960's when it stabilized at roughly 600,000 trips per average weekday.

This trend has occurred in mass transit systems across the United States and has generally been attributed to such factors as increasing affluence and accompanying automobile ownership, growing suburbanization, and widespread highway construction.

In the early 1970's, average weekday ridership was as low as 480,000 trips. The time period from 1976 to 1980 showed an indication of a possible reversal of this declining trend. Factors which may have influenced this increase in ridership include the rising cost of gasoline, constraints on its availability, and the expansion of transit services into suburban areas. With the fare increases of 1980 and 1981 and an accompanying series of service reductions, however, trips have dropped back to the levels seen in the early 1970's. This trend is evident on each of the rapid transit lines in the system. Figure 2-6 displays boardings by station for an average weekday in November 1981.

In 1980, the Green Line carried the greatest proportion of riders (39 percent) on rail transit lines.* The Blue Line carried the fewest number of passengers (22,700), representing only 8 percent of all transit riders. The Red Line carried almost one third, and the Orange Line 21 percent of these trips. These proportions



*From 6/81-1/82
the Dorchester
Rapid Transit Ext.
(DRTX) was closed.

RAPID TRANSIT RIDERSHIP BY STATION
NOVEMBER 13, 1981

Figure
2-6

have shown variation over time but generally have stayed within a few percentage points of these values. The number of riders on each line are given in Table 2-4 for 1950-1980.

The commuter rail ridership levels are shown in Table 2-5. the most recent trend is an increase in the number of trips (+20 percent) over the past few years, despite fare hikes during that time. The increase has been evident on all lines with the exception of the Reading Line.

Bus ridership has dropped over time; however, information to attribute these losses to specific routes is not available. Furthermore, bus service has been changed in response to demand generated by new activity centers, residential areas, or other factors, making a direct comparison inappropriate.

2.4 CHRONOLOGY OF CHANGES IN MBTA SERVICE LEVELS AND FARES

Efforts have been made to alleviate financial problems by altering both the level of service provided and the cost of transit fares. Since late in 1979, three major service decreases have been instituted, with the most significant change being made during the winter timetable (beginning in January) of 1981. From April 1981 until June 1982, there has been a phased restoration of service with previous levels of service nearly restored by the commencement of the Summer 1982 Timetable. Also during this time period, the base cost of a rapid rail fare was raised from 25 cents in 1979 to 50 cents in 1980, and later to 75 cents in 1981. The estimated impacts of this fare increase are the subject of much of the remainder of this report. In the spring of 1982, a further revision was made in the rapid transit base fare when it was reduced to 60 cents. Table 2-6 details the chronology of the service and fare changes made during this time period.

2.4.1 Recent Service Level Changes

A detailed examination of the cuts made in the beginning of the winter of 1981 follows. Facing financial problems, the MBTA Board of Directors adopted a revised schedule with service changes aimed at reducing surface manpower requirements by 20 percent (or approximately 300 surface operators). This set of service reductions, concentrating on the high cost and low ridership MBTA-run and MBTA-subsidized transit services, was initiated during the first quarter of 1981. Specific actions proposed and implemented by the Board of Directors included:

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*These proportions do not include boardings at the six transfer stations in downtown Boston.

Year	Six Downtown Transfer Stations	Red Line	Orange Line	Blue Line	Green* Line	To
1950	198,400	196,100	213,200	36,400	186,600	830
1951	185,900	189,400	207,000	34,500	178,900	795
1952	182,200	179,200	194,200	38,500	175,400	769
1953	172,600	181,100	187,300	37,400	168,300	746
1954	180,600	175,800	178,600	37,000	165,600	737
1955	159,200	159,700	157,600	33,300	151,300	661
1956	154,800	153,100	150,800	33,500	148,300	640
1957	163,100	147,900	150,800	32,900	148,400	643
1958	142,100	143,300	144,100	31,900	144,200	605
1959	146,000	151,300	141,300	31,200	152,000	621
1960	140,000	143,400	139,000	30,200	151,700	604
1961	126,600	109,800	97,300	28,300	120,200	482
1962	120,900	105,500	90,100	27,000	111,000	454
1963	120,900	105,000	89,100	25,800	111,800	452
1964	111,200	103,900	86,100	25,700	115,000	441
1965	110,000	105,000	84,700	26,600	121,900	448
1966	119,900	109,800	84,600	26,800	127,200	460
1967	121,000	114,000	83,000	25,200	125,300	468
1968	109,200	105,000	74,300	25,700	118,500	437
1969	115,700	104,500	78,000	27,600	119,100	444
1970	112,400	100,800	70,000	27,500	113,400	424
1971	116,600	108,700	70,800	28,400	112,900	437
1972	104,600	109,400	67,200	25,400	109,500	416
1973	104,000	105,900	62,500	28,200	103,100	403
1974	100,300	111,100	58,200	25,200	102,700	397,
1975	96,900	103,400	57,100	22,100	105,500	385,
1976	100,500	99,600	53,400	23,500	104,800	381
1977	93,200	106,100	59,200	23,600	112,800	394,
1978	111,800	110,500	65,300	24,200	116,400	428,
1979	109,400	116,800	61,900	28,100	127,400	443,
1980	88,800	103,500	59,400	22,700	113,800	388,

Source: MBTA ,Office of Service Planning

*Includes surface portions of the Green Line.

Counts are typically taken in the first week of December.

**In 1961, transfers from surface riders to rapid transit were no longer used and thus no longer counted as a portion of rail transit riders.

NUMBER OF RAIL TRANSIT RIDERS PER AVERAGE WEEKDAY

TABLE 2-

r	Total	Eastern Line	Reading Line	New Hampshire Line	Fitchburg Line	Bedford Line	South Sudbury Line
6	20,010	4,560	7,090	5,330	2,550	230	250
7	20,760	5,620	6,770	5,370	2,530	230	240
8	19,580	5,290	6,450	4,920	2,570	190	160
9	19,070	5,250	6,380	4,560	2,530	200	150
0	20,200	5,290	6,430	5,690	2,440	190	160
1	20,240	5,090	6,450	5,800	2,460	190	250
2	19,670	5,500	5,830	5,800	2,410	130	
3	17,610*	4,660	5,430	4,870	2,540	110	
4	**	-	-	-	-	-	-
5	16,840*	4,870	5,030	4,700	2,120*	120	
6	16,370*	4,740	4,570	4,120*	2,940	90	
7	16,530	5,370	4,380	4,020	2,760	*	
8	-	-	-	-	-	-	-
9	17,560	5,590	4,150	4,520	3,300		
0	19,000	6,690	4,190	3,910	4,210		
1	19,560	7,010	4,420*	4,270	3,860		

SOUTHERN DIVISION

r	Total	Needham	Framingham	Franklin	Rhode Island	Stoughton
6	11,000					
7	10,900					
8	10,500					
9	9,900	NOT AVAILABLE BY LINE [Penn. Central]				
0	9,600					
1	8,900					
2	8,300					
3	9,200					
4	10,500	2,730	1,210	2,030	1,960	2,570
5	10,700					
6	11,200					
7	12,990	3,240	1,420	2,630	2,460	3,240
8	12,300					
9	13,900	2,600	1,550	2,980	2,930	3,840
0	14,930	***	3,140	3,820	3,940	4,030
1	15,890		3,010	4,530	3,520	4,810

Represents a major service change.
Not available.
Bus replacement.
rce: 1966-1973 - Northern Division, B&M Audit Summaries; 1966-1973 - South Division, Penn Central; 1974-1981 - MBTA Audits.

COMMUTER RAIL AVERAGE WEEKDAY RIDERSHIP (1966-1981)
NORTHERN DIVISION

TABLE 2-5

November, 1979	• Bus Service Cuts Peak Vehicle Requirements reduced by 50 buses
July, 1980	• RTL Fare Increase Base fare increased from 25¢ to 50¢
Winter, 1981	• Sunday Bus Service Cuts • RTL Station Closings • Commuter Rail Service Reduction • Downtown Crossing Service Terminated
April, 1981 (Spring Timetable)	• Bus Service Cuts 18% of weekday trips terminated • Sunday Service Hours reduced Rail: 6:00 AM - 11:00 PM Bus: 7:00 AM - 7:00 PM
June, 1981	• DRTX closed for reconstruction
August, 1981	• Systemwide Fare Increase RTL Base Fare increased from 50¢ to 75¢ Bus Base Fare increased from 25¢ to 50¢
September, 1981 (Fall Timetable)	• Sunday Bus Service Hours extended to 11:00 PM • Bus Service Improvement/Restoration on 30 routes
January, 1982 (Winter Timetable)	• Bus Service Improvement/Restoration on 12 routes • Bowdoin Station Reopened • DRTX reopened.
May, 1982 (Spring Timetable)	• RTL Fare Reduction Base fare decreased from 75¢ to 60¢ • Downtown Crossing Service Restored • Bus Service Improvement/Restoration on 12 other routes • Sunday Evening Service Hours extended to 1:00 AM on all modes • RTL and Green Line Headway Improvements
June, 1982 (Summer Timetable)	• Arborway Streetcar Service Restored • Symphony Station Reopened

CHRONOLOGY OF MBTA SERVICE LEVELS AND FARES

TABLE 2-6

- Curtailing Sunday late evening service on rapid transit, streetcar, trackless trolley, and bus routes, providing a total of 12 hours of Sunday service.

- Closing Bowdoin and Symphony stations on the rapid transit lines.

- Discontinuing Sunday daytime service (only) on 60 bus routes.

- Reducing or eliminating subsidies for local bus services.

Furthermore, to accomplish the cutbacks in service, the Office of Service Planning developed a set of basic guidelines and methods for instituting emergency bus service reductions which included: (1) the elimination of bus routes, (2) the elimination of route segments, (3) the increasing of headways (reducing the frequencies of trips) especially during peak periods, (4) the reduction of the hours during which bus service is provided, and (5) changing the express bus services provided. Service changes included:

- Changing the headways or making other schedule reductions for more than 106 bus routes.

- Discontinuing 28 bus routes entirely.

- Combining 3 pairs of bus routes.

- Discontinuing route segments in 15 bus routes.

- Discontinuing 2 bus routes during off-peak periods.

Of all bus routes, 88 percent had some changes made in scheduled headways. These alterations were made largely as the result of a policy decision to raise the peakload standards from 140 percent of designed seating capacity to 160 percent during the peak 30 minutes for all bus routes. A display of the vehicle assignments before and after the service changes may be found by comparing Table 2-2 (A) with Table 2-2 (B).

In addition, changes were made by the Commuter Rail Department which included:

- Closing 9 of the commuter rail stations on 6 branches.

- Instituting a 9.7 percent cut in the total number of commuter rail trains operated.

Beyond scheduled reductions in service, there has also been a change in the quality of service and dependability. In 1979, a systemwide average of 96 percent of all scheduled trips were made. Of those trips not made, 11 percent of the time the cause was due to a lack of available crew to make the trip. In 1980, a systemwide average of 97 percent of all scheduled trips were made.

In 1981, average weekday service saw an average of 97 percent of all scheduled bus trips run (see Table 2-7A) and 95.77 percent of all rapid transit trips run (see Table 2-7B). On a systemwide level, an average of 96.9 percent of all scheduled trips were made in 1981. Obviously, this is not a significant change from previous years; however, what is significant is that 40.3 percent of all trips not made (44 percent for rapid transit, 39 percent for buses) occurred due to a lack of personnel. Accompanying a reduction of all scheduled trips, the vehicle availability and the condition of those vehicles used was improved due to the increase in total vehicles available for trips to be made.

There are several reasons for trips not being made, principally disabled vehicles, lack of vehicles, or lack of available crew members. A significant factor in the issue of crew availability which has accompanied other major service cuts, has been a reduction in the "cover list" of available drivers. This list of vehicle operators is a pool of additional manpower used to fill in for staff who are ill, on jury duty, or personal leave, or who retire or resign in the middle of a timetable. (Presently, hiring is conducted at the start of each new timetable (quarterly)

Historically, the cover list was maintained at 14 percent (of scheduled runs) in excess of the drivers needed for scheduled operations. In September of 1979, this percentage was altered to 12 percent, and in April of 1981, it was further reduced to 9 percent. A 9 percent cover list appears to create a scarcity of cover personnel, especially by the end of a given timetable at which point the actual percentage of cover personnel has dropped to near zero.

The results of this lack of cover personnel become a type of service reduction. Table 2-8A shows, for example, that of all 1981 average weekday bus trips scheduled but not made, 39 percent failed to occur due to a shortage of crew. This is 1 percent of daily total trips. Table 2-8B shows the same data for the rapid transit system.

During the course of 1981, a number of the instituted service reductions were "discontinued," thereby restoring previous levels of service. By February of 1982, more than half of the bus routes affected had been at least partially restored to previous service levels with the major restoration of service having occurred in April of 1981. Sunday evening service has been restored as have many of the other types of reductions in conjunction with the 1981 fare increase. It is estimated that original cuts made in the beginning of 1981 reduced service, as measured by vehicle miles, by 20 percent. The MBTA estimates that total service reduction in November of 1981 is between 12 percent and 13 percent of the bus service provided in 1980.

Garage	Scheduled[1] Trips	Trips[1] Run	Percentage of Trips Run
Cabot	2,301	2,224	96.52%
Arborway	1,473	1,444	97.60%
Quincy	614	604	98.35%
Bennett Street	873	840	95.96%
Salem	1,241	1,218	97.77%
Lynn	619	609	98.20%
TOTAL	7,121	6,939	97.20%

[1] Included school trips.

Source: 1981 MBTA Service Tracking Reports Annual Report.

TABLE 2-7A

1981 AVERAGE WEEKDAY SERVICE PERFORMANCE BY BUS GARAGE (JANUARY-DECEMBER)

Line	Scheduled Trips	Trips Run	Percentage of Trips Run
Red Line	743	691	93.00%
Orange Line	498	489	98.15%
Blue Line	533	525	97.51%
Green Line*	726	694	95.55%
Mattapan	169	163	96.30%
TOTAL	2,675	2,562	95.77%

Source: 1981 MBTA Service Tracking Reports Annual Report.

*Does not include Northeastern University/ Brigham Circle trips.

TABLE 1981 Average Weekday Service Performance (January-December) By Rapid Transit Line

Garage	Total Trips Not Run	Vehicles[1] Not Available	Percentage of Vehicles Not Available	Crew Not Available	Percentage of Crew Not Available	Disabled[2] Vehicles	Percentage of Disabled Vehicles	Miscellaneous[3]	Percentage of Miscellaneous
Cabot	80	17	21%	34	2%	25	32%	2	2%
Arborway	35	2	6%	17	49%	7	19%	3	10%
Quincy	10	*	*	4	42%	3	28%	1	12%
Bennett Street	35	17	49%	7	20%	6	18%	3	9%
Salem	28	4	15%	10	35%	6	22%	3	13%
Lynn	11	*	*	5	44%	5	42%	0	2%
TOTAL	199	41	20%	77	39%	52	26%	12	7%

Data represents average annual weekday.

[1] Vehicles not available for a particular run due to breakdown on a previous run or to mechanical problems that require light repair work.
[2] Run started but not completed because of vehicle malfunction.
[3] Includes runs not made because of weather.

Source: MBTA Service Tracking Reports Annual Report, 1981**.

*Absolute number of less than .5 percent ≤ .02.
**Note that in the report, trips not run include school trips not run because of school vacations, holidays, snowdays, and rescheduled hours. These trips are not reflected in the above table.

TABLE 2-8A

1981 AVERAGE WEEKDAY BUS TRIPS NOT RUN

Line	Trips Not Run	Vehicles[1] N/A	Percentage of Vehicles N/A	Crew N/A	Percentage of Crew N/A	Disabled[2] Vehicles	Percentage of Disabled Vehicles	Headway	Percentage of Headway	Miscellaneous[3]	Percentage of Miscellaneous
Red Line	52	17	32%	12	23%	12	23%	11	21%	*	*
Orange Line	9	*	8%	6	67%	*	3%	*	9%	1	11%
Blue Line	13	*	*	9	69%	*	4%	2	15%	1	8%
Green Line	32	10	31%	19	59%	2	7%		0%	1	3%
Mattapan	6	1	17%	4	56%	1	19%		0%	*	*
TOTAL	113	29	25%	50	44%	16	14%	13	12%	5.0	4%

[1] Vehicles not available for a particular run due to a breakdown on a previous run or to mechanical problems.
[2] Run started but not completed because of vehicle malfunction.
[3] Includes runs not made because of weather.

Source: MBTA Service Tracking Reports, 1981.

*Absolute number of less than .5 percent $\leq .02$.

TABLE

1981 AVERAGE WEEKDAY RAPID TRANSIT TRIPS NOT RUN (JANUARY-DECEMBER)

2.4.2 Fare Levels on the MBTA

Historic Fare Levels and Structures

Base fares on the MBTA system changed very slowly in the three decades prior to 1980. bus fares went from 10 cents in 1950 to 25 cents in 1980, with 5 cent increases in 1954, 1968, and 1975 (an average increase of one half cent per year). Rapid transit fares went from 15 cents in 1950 to 20 cents in 1954 and then to 25 cents in 1968 (an average increase of one third cent per year). Over this time period, several other changes were made in the fare system. The most significant change was the elimination of free transfers between subways and buses which began in 1961. In 1969, the state passed legislation providing a reduced fare to citizens over the age of 65 who reside in the MBTA district. Dime Time, an experimental program that reduced rapid transit fares to 10 cents between 10 AM and 1 PM, Monday through Friday, was in effect between 1973 and 1975.*

Current Fare Levels and Structure

In 1980, the MBTA began to make additional changes in the fare structure. In July, rapid transit fares increased 25 cents; combined trips on the subway and the Arborway, Commonwealth Avenue, or Beacon Street lines increased by 5 cents (see Figure 2-7). commuter rail fares were raised an average of 19 percent. Rapid transit fares had not been raised since 1968; railroad fares were last raised in 1975.

In August 1981, the MBTA initiated a systemwide fare increase. The local bus fare went from 25 cents to a zonal system with a 50 cent base fare. The base rapid transit fare rose from 50 cents to 75 cents. Express bus fares also increased to a maximum of $1.50/trip. This fare structure is shown in Figure 2-8 for rapid transit and Table 2-9 for buses. Senior citizens are allowed to ride free between 9:30 AM and 4:00 PM on weekdays. Students are offered fares at half the adult full fare. At the same time, the cost of prepaid passes, good on combination bus to rapid transit trips, was changed to reflect the base cost of 16 round trips instead of 18 round trips.

In 1982, in response to decreased ridership, due in part to the higher fares, the MBTA adjusted the rapid transit fares once again. The base fare price, beginning in May 1982, was lowered from 75 cents to 60 cents and the fares on surface transit were retained using the zonal breakdown to determine cost.

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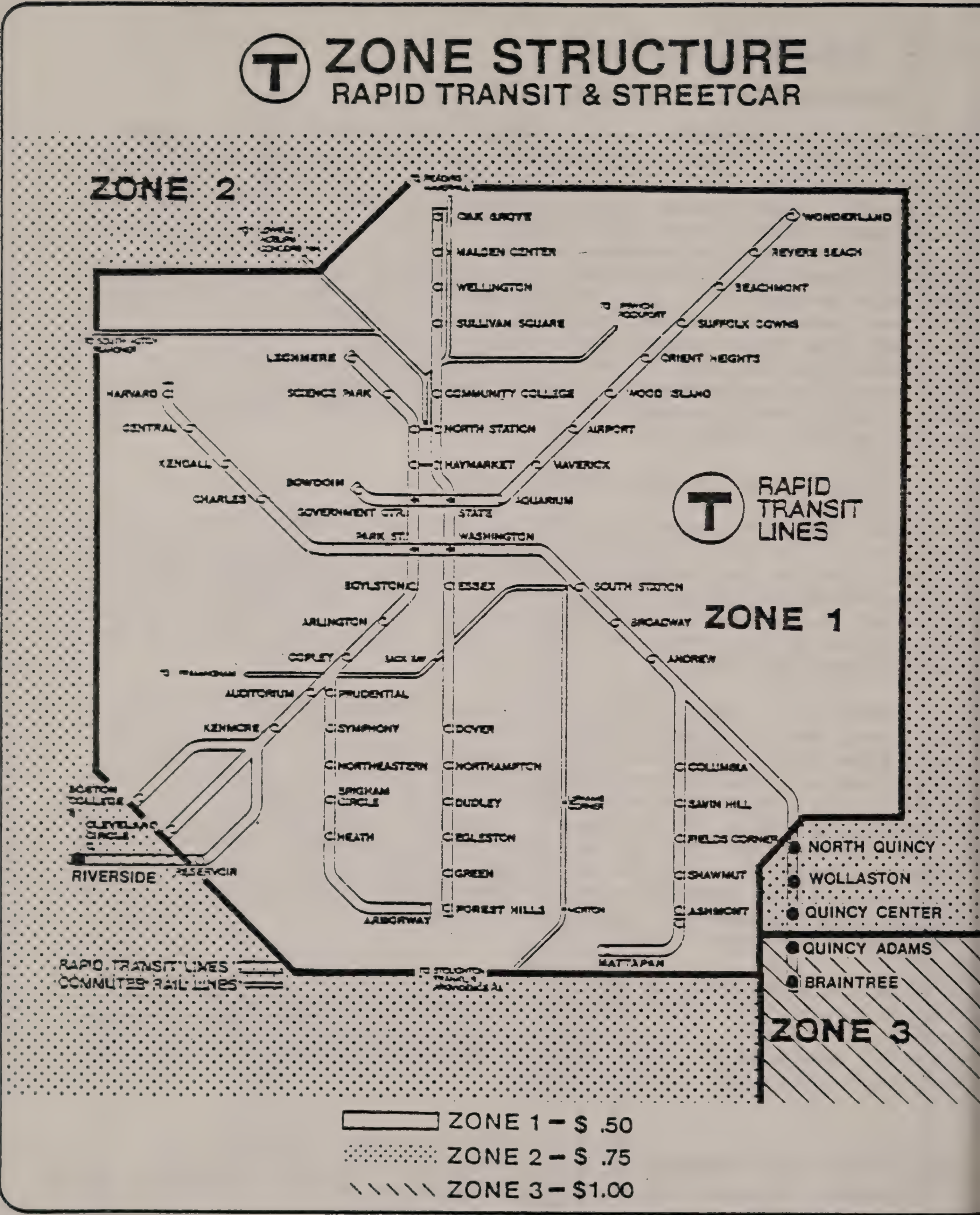
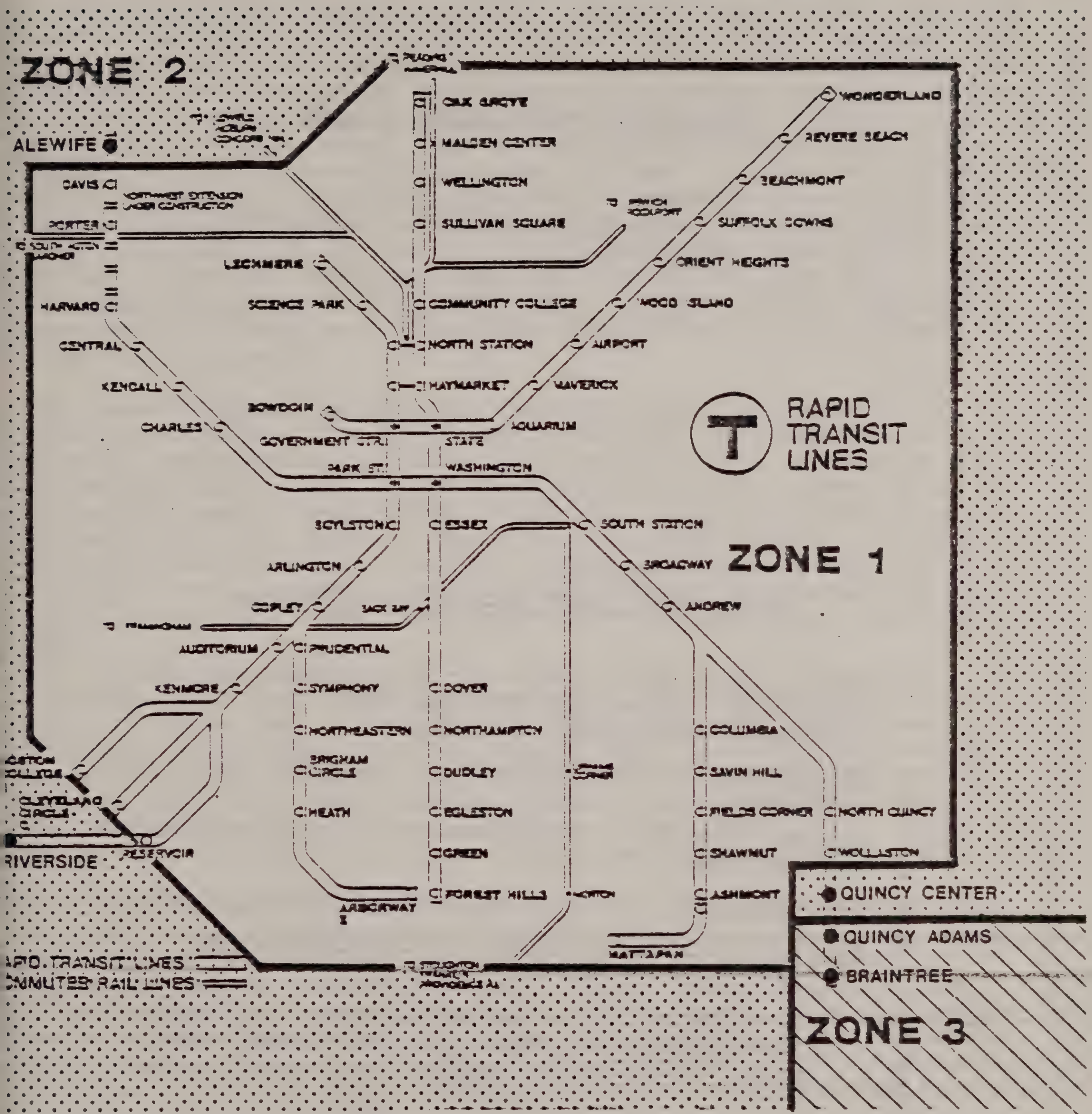
*Dime Time was extended until 2 PM in 1974 in an effort to increase off-peak ridership. The program is discussed more fully in Section 5.0.



1980 FARE STRUCTURE

Figure 2-7

ZONE STRUCTURE
RAPID TRANSIT & STREETCAR



▭ Zone 1 - $ .75

░ Zone 2 - $1.12½ or $1.125 each way

▨ Zone 3 - $1.50

1981 FARE STRUCTURE

Figure 2-3

Zonal Fare Tariff - Bus System

Zone	Route Miles	Fare
1	0 - 6	$0.50
2	6 - 9	0.75
3	9 - 12	1.00
4	12 - 15	1.25
5	15 +	1.50

Categories, Fare Tariff - Bus System

- Base Fare - $0.50, good for all routes that are less than 6 miles and for the first 6-mile zone on routes longer than 6 miles
- Zone Fares - Additional $0.25 for each 3-mile increment.
- Express Premium - Additional $0.25 for express bus services.
- Maximum Fare - $1.50, including express premium.
- Senior Citizen, Children, and Student Fares - Consistent with rapid transit fare policy.

NOTE: Zone Fares may be adjusted based on geographic, topographic, or other unusual conditions in order to establish logical zone boundaries.

CHANGES IN BUS FARES, AUGUST 1981

TABLE 2-9

Analysis of Change in Fares

Changes in the real cost of transit in Boston cannot be understood solely on the basis of changing base fares. The true cost of transit reflects the changing relationship between the base fares and the average fare and also the impact of inflation. The base fares represent an accurate picture of the cost of transit for riders who use a single mode and obtain no discounts from passes or special fares. Due to discounts offered to various groups of riders, however, an average fare is more meaningful for comparisons. For instance, the use of prepaid discount passes has increased dramatically in recent years. The elderly have gone from paying full fare to paying half fare beginning in 1969, to less than half fare in 1980, and finally to free during the off-peak beginning in 1981 and 1982. Prior to 1961, transfers from bus-to-subway were free; now riders who link trips must pay fares on both modes.

For these reasons, an average fare has been calculated to facilitate comparisons. The 1980, 1981, and 1982 figures are not directly comparable to those prior to 1980, due to changes in estimation techniques. The average fare is calculated by estimating the amount paid by each transit rider for a complete linked trip. The reduced fares for the handicapped, elderly, and students, and the increased use of passes, have caused the average fare to become a smaller and smaller percentage of the total linked trip base fare ever since transfers were abolished in 1961.

Although fares have been increasing in an absolute sense, the value of money has fallen dramatically. Figure 2-9A shows the average fare plotted in both current and constant 1967 dollars. When inflation is taken into account, it is evident that the average fare fell dramatically between 1969 and 1979. Even when the 1980 and 1981 fare increases are taken into account, the real average fare in 1982 is lower than it was between 1969 and 1972.

Figure 2-9B shows fares plotted against inflation and the price of gasoline, using 1967 as an index = 100 for each of the variables.* Since 1974, the indexed cost of gasoline has increased faster than the Consumer Price Index (CPI) and MBTA fares. Gasoline is considered in this analysis, since it represents a major component of the cost of automobile use, an alternative mode of travel to public transportation. It, therefore, plays an important role in determining the impacts of an increase in the fares on the MBTA.

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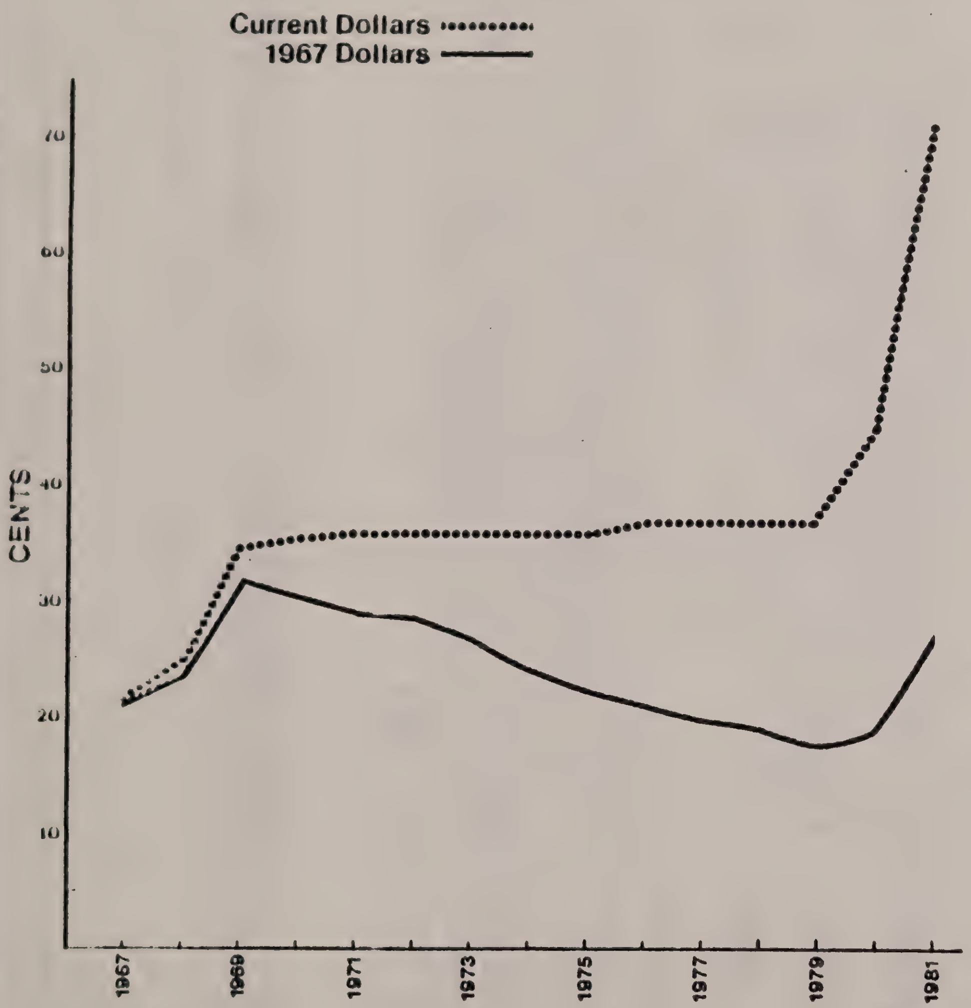
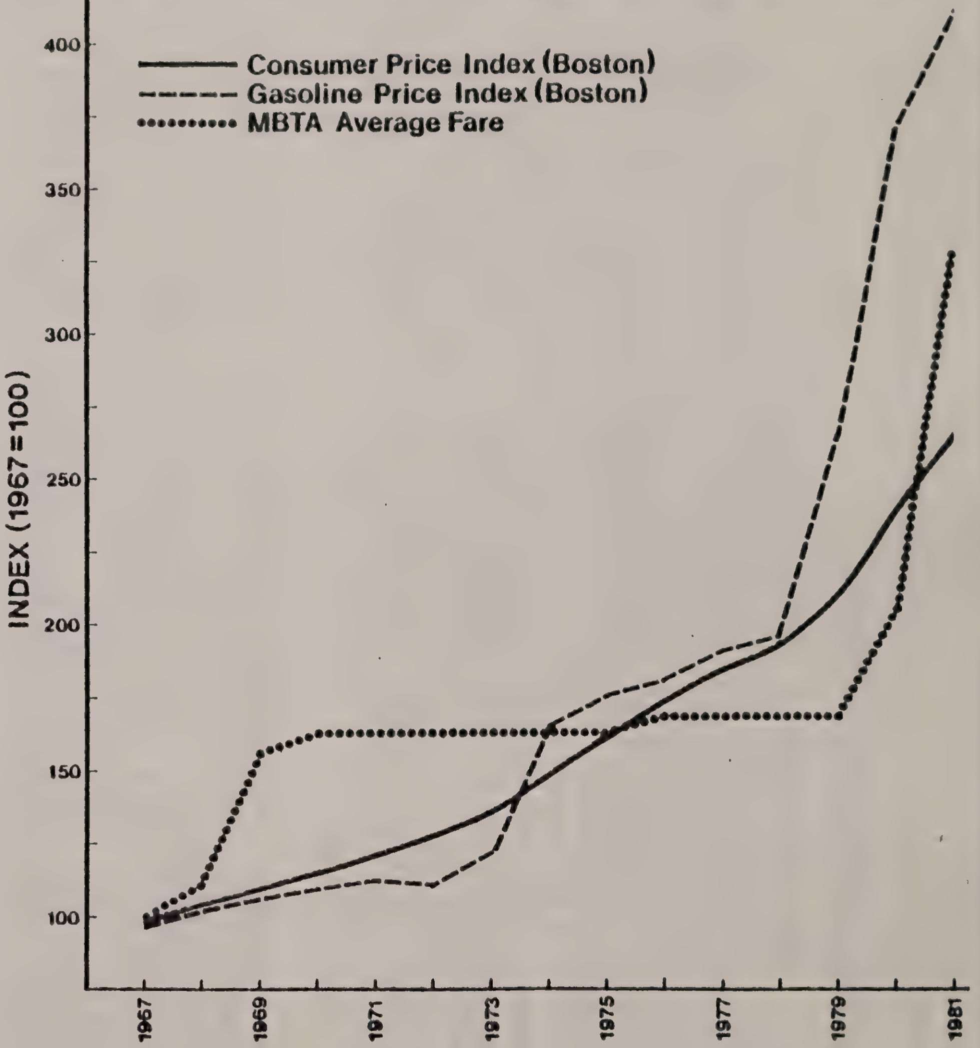
*The CPI is developed using a base of 100 for 1967. The two other variables, fares and gasoline, were indexed also to 1967.

MBTA AVERAGE FARES IN CURRENT AND CONSTANT DOLLARS



MBTA FARES, FUEL COST, AND OVERALL INFLATION



FIGURE

2.5 COST OF MBTA SERVICE

The cost of providing MBTA service can be described in two broad categories: operating expenses and capital expenses. Capital expenses are funds spent for improvements or additions to the physical plant or equipment. Eighty to eighty five percent of capital expenses are financed with federal (Urban Mass Transportation Administration) funds. The remaining fifteen to twenty percent of capital expenses are financed through the issuance of long-term bonds. The interest and principal on these bonds are paid by the MBTA, and represent a fixed cost in the annual budget. With increasing capital expenditure in recent years, these fixed costs have become a greater component of the annual budget.

Operating expenses are those recurring costs in the transportation system, such as salaries and wages, maintenance, energy, taxes, interest on unfunded debt, insurance, and supplies. Operating expenses can be divided into two categories: MBTA operations and private carrier contract costs. Under terms of contracts with private carriers, such as the Boston and Maine Railroad and Rapid Transit Incorporated, the MBTA pays for the cost of service not covered by fare revenue. This net cost of service appears in the MBTA budget. For the purpose of this analysis, only the costs of the MBTA-run system will be considered as operating expenses.

Table 2-10 and Figure 2-10 display trends in average fare and operating costs from 1967 to 1981 in both real and current terms. Operating costs and revenue from transportation are summarized in Table 2-11.

Overall, the fares charged by the MBTA do not cover the cost of providing transit service. Passenger revenue, which in 1970 covered over 50 percent of the cost of operating the MBTA, accounted for less than 26 percent of the cost of operations in 1980. This trend has recently been reversed, with passenger revenue covering 31 percent of operating costs in 1981.

Adjusting for inflation (1967 dollars), operating cost per passenger in 1980 was 66 cents, with the average fare per passenger at 16.7 cents. The difference between the cost and fare has lessened in 1981, with the real operating cost per passenger at 64 cents, and the real average fare per passenger at 20.9 cents.

The cost per mile of operation of the MBTA is higher than the cost/mile of operation experienced by other transit authorities. This cost/mile value for other transit authorities is shown in Table 2-12. It must be noted that different transit authorities employ different accounting procedures and may consider different formulas for calculating costs (for example, not including

	Average Fare Per Passenger			Cost Per Passenger[3]		Cost Per Mile[4]		
Year	Current Value[1] (Cents)	Real Value[2] (Cents)	CPI	Current Dollars	Real Dollars	Current Dollars	Real Dollars	Percent of Costs Covered by Passenger Revenue[5]
1967	21.7	21.7	1.000	0.36	0.36	1.75	1.75	65.1
1968	24.3	23.4	1.038	0.42	0.40	1.78	1.71	63.2
1969	34.3	31.2	1.099	0.55	0.50	2.03	1.84	68.5
1970	35.3	30.2	1.169	0.69	0.59	2.43	2.08	55.8*
1971	35.7	29.0	1.231	0.74	0.60	2.71	2.21	47.7**
1972	35.8	28.2	1.270	0.83	0.65	2.96	2.33	43.2
1973	35.8	26.5	1.351	0.92	0.68	3.28	2.43	38.7
1974	35.7	24.0	1.488	1.08	0.73	3.81	2.56	32.9
1975	35.7	22.0	1.623	1.19	0.73	4.15	2.56	30.0
1976	36.4	20.9	1.742	1.21	0.69	4.48	2.57	29.9
1977	36.4	19.9	1.829	1.31	0.71	4.96	2.70	28.0
1978	36.5	18.9	1.931	1.33	0.69	5.30	2.75	27.4
1979	36.5	17.3	2.110	1.45	0.69	5.89	2.79	25.1
1980	40.5***	16.7	2.425	1.57	0.66	6.50	2.72	25.7
1981	55.8***	20.9	2.666	1.71	0.64	7.35	2.76	31.2

(1) Represents average fare paid throughout the year

(2) Real value represents 1967 dollars; real average fare equals average fare divided by CPI.

(3) Operating expenses divided by total passengers; operating expenses are for all MBTA-operated services excluding subsidized and privately-owned carriers.

(4) Operating expenses divided by total revenue miles; operating expenses are for all MBTA-operated service excluding subsidized and privately-owned carriers.

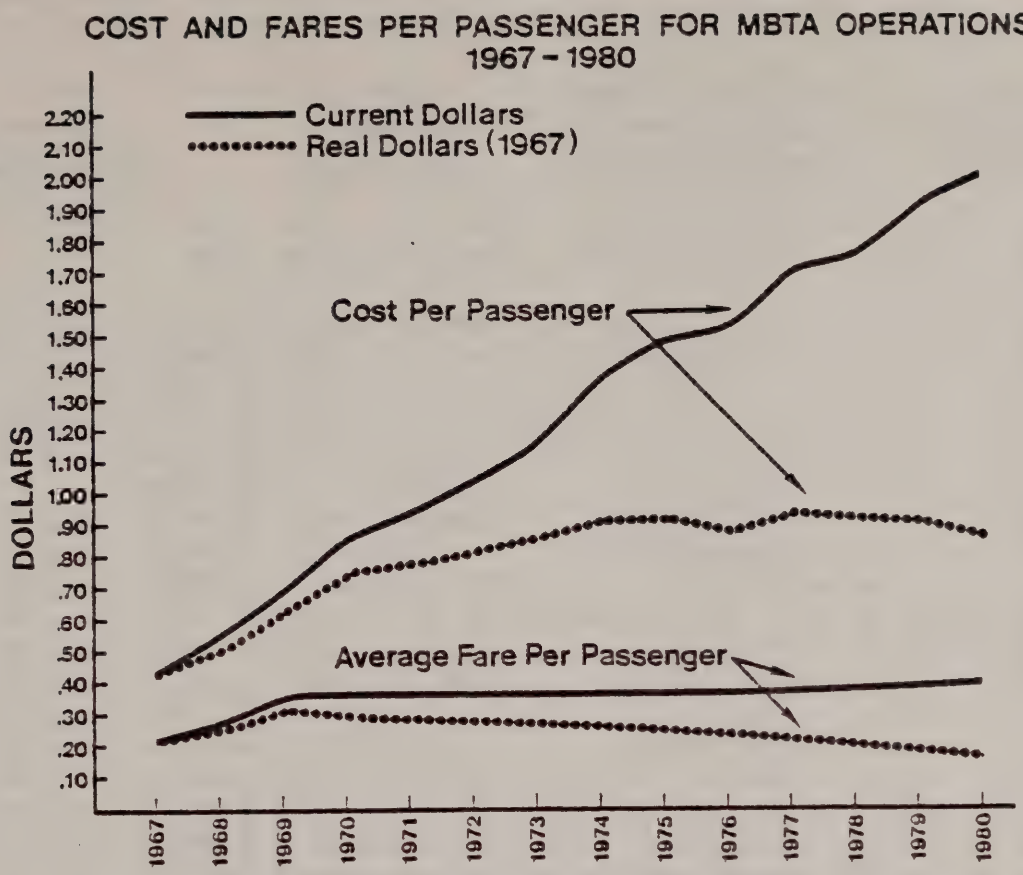
(5) Transportation revenue divided by operating expenses.

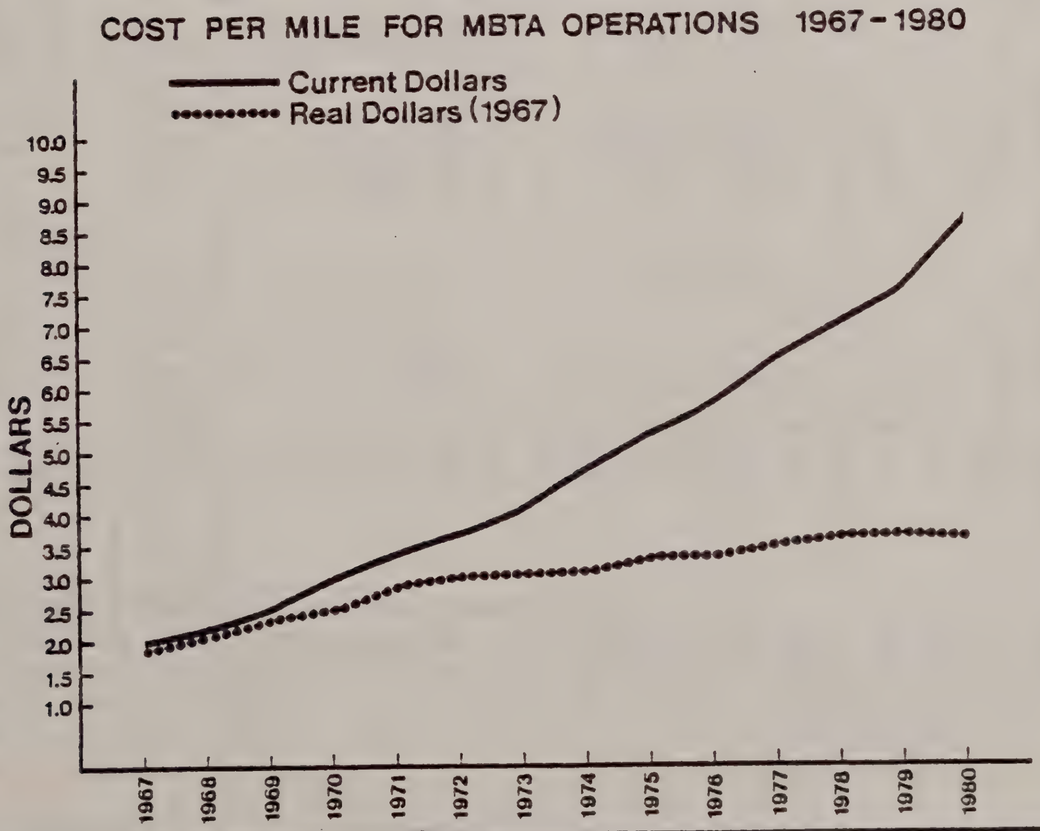
*First full year of Eastern Massachusetts Service.

**Opening of the South Shore Red Line.

***Not directly comparable; derived using a different method.

Source: MBTA Treasurer's Office; CTPS.





TRENDS IN COSTS/PASSENGER AND COST/MILE ON THE MBTA

Figure
2-10

	Operating Expenses** ($ Millions)		Revenue from Transportation*** ($ Millions)
Year*	Current Dollars	Real Dollars	
1967	66.5(2)	68.6	43.3
1968	76.4(2)	76.2	48.3
1969	92.4(2)	84.5	63.3
1970	108.7(2)	93.3	60.7
1971	111.6(2)	90.0	53.2
1972	124.3(2)	97.6	53.7
1973	135.0(2)	99.0	52.2
1974	156.3(2)	104.7	51.5
1975	170.9(2)	103.6	51.3
1976	177.3(2)	101.2	53.1
1977	190.8	104.3	53.5
1978	201.6	104.4	55.2
1979	225.7(1)	104.3	56.7
1980	256.8	105.9	66.2
1981	262.4	98.4	81.8

(1) Unreimbursed Cost of Service - Cost of provided service for commuter rail was not included.

(2) Penn Central depreciation, amortization, and interest incomes were ignored.

*Expenses and revenues based on calendar or fiscal year, depending on MBTA budget format.

**Does not include private carrier subsidies.

***Does not include revenue from private carriers and other railway operations.

Source: MBTA 1981 Current Expense Budget and Auxiliary Data.

Transit Authorities		Total Operating Expenses	Annual Vehicle/ Passenger Car Revenue Miles	Cost Per Vehicle Mile (in dollars)
NYCTA/MABSTOA	MB	449,817,500	85,509,000	5.26
	RR	836,179,260	232,903,970	3.59
Chicago	MB	195,493,450	81,017,500	2.41
	RR	100,980,740	48,862,800	2.07
So. Calif. RTD	MB	228,743,180	86,061,400	2.67
SEPTA	MB	79,467,991	33,642,690	2.36
	RR	38,304,083	13,719,540	2.79
	SC	34,284,446	5,824,910	5.89
	TB	4,202,125	1,510,219	2.78
WMATA	MB	142,360,430	42,928,955	3.32
	RR	51,710,941	16,816,448	3.07
MBTA*	MB	85,759,572	22,216,723	3.86
	RR	106,357,782	10,114,758	10.52
	SC	16,449,707	5,152,085	3.19
	TB	3,945,370	812,395	4.86
	CR	41,192,191	5,794,093	7.11
Trans. of NJ	MB	103,582,940	47,651,290	2.17
Greater Cleveland	MB	57,641,204	20,186,000	2.86
	RR	8,073,509	2,396,088	3.37
	DR	2,194,660	643,379	3.25
PAT Pittsburgh	MB	61,020,701	33,220,471	1.84
	SC	9,107,542	1,784,621	5.10
Baltimore	MB	45,784,253	22,545,147	2.03
	DR	511,918	253,000	2.02
Bi-State DA-St. Louis	MB	65,214,862	23,798,398	2.74

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*MBTA figures are for calendar year 1979.

Source: U. S. DOT, Transportation Systems Center, Section 15, "Annual Report," 1981.

Key: MB - Motor Bus
SC - Street Car
DR - Demand Responsive
RR - Rapid Rail
TB - Trolley Bus
CR - Commuter Rail

OPERATING EXPENSES PER VEHICLE MILE (FISCAL YEAR ENDING BETWEEN 7/01/78 AND 6/30/79

TABLE 2-12

interest on unfunded debt). As a result, information presented in Table 2-12 may not provide a true comparison of operating costs. A more detailed comparison of MBTA costs with those of other transit properties has been conducted for the MBTA Management Practices Study.

2.6 SOURCES OF FUNDING

As already noted, only 21 percent of the funding for the MBTA is generated by passenger revenue. The remainder comes from the taxpayer, indirectly through the state (approximately 40 percent in 1980), the federal government (8 percent), and the local cities and towns (26 percent). The amounts received from each of the sources between 1971 and 1980 are shown in Table 2-13 and Figure 2-11.

Although funding from all levels of government increased in absolute terms, the relative percentage of MBTA costs carried by each source has increased for some governments and decreased for others (see Figure 2-12). The cities and towns in the MBTA district provided nearly 77 percent of the total taxpayer assistance in 1971; the state paid 22 percent in the same year.

The federal Section 5 operating assistance is scheduled to be phased out over the next three years. It is likely that increased farebox revenue would be put toward maintaining current service levels with reduced federal funding. Previously, an increase in revenue from fare increases would have affected the deficit and the amount paid by the local cities and towns in the MBTA district and by the state.

2.7 OPERATING FACTORS AND TRENDS

The category of operating factors and trends contains several different types of indicators which may be used to assess recent changes in the system. For example, this section discusses trends in energy efficiency and consumption in the MBTA system, trends in peak-load factors, and the trend in overall efficiency as measured by cost per passenger-mile. Also, this section provides information on the capacities of the MBTA system, both with and without the current constraints of vehicle fleet size and signal system capabilities.

2.7.1 Energy Use and Efficiency

The energy efficiency of the MBTA has been increasing over the last few years. From 1980 to 1981, energy efficiency increased by 2.4 percent (based on revenue miles), and energy consumption declined by 12 percent. As displayed in Table 2-14, energy efficiency (based on revenue miles) increased by 11.5 percent* from 1.0283 in 1978 to 1.1467 in 1981, and energy consumption is down by 15.7 percent in 1981.

The improvements in energy efficiency do include the closing of the South Boston Power Plant. Since energy use by the system is predominantly electric, the closing of the South Boston Power Plant produces a large impact on the energy savings. However, Table 2-14 indicates that use of automotive fuels has also declined significantly in addition to electric energy.

Two projects are now underway to reduce automotive energy use. The Authority has undertaken a program to evaluate the effectiveness of a diesel fuel additive in improving MPG. Manufacturer claims of 10 percent or greater fuel economy, if correct, will result in savings of over 600,000 gallons of diesel fuel per year.

The Authority has also awarded a contract to supply and install an automotive fuel management pilot system to automatically control and monitor gasoline dispensing. If the project is successful, the Authority will consider installing the management system at all locations to control gasoline and diesel fuel. Furthermore, the Authority is eliminating the use of No. 6 heating fuel at two major locations (Charlestown and Everett) and replacing the heating systems with more energy efficient boilers (dual gas/No. 2 oil boilers have been installed at Everett).

In the area of electric power, obsolete 25 HZ power conversion facilities are being replaced with energy efficient, lower energy cost substations to further reduce dependence on 25 HZ power purchased from Boston Edison Company through the inefficient frequency converter at South Boston.

The energy use reduction from 1980 to 1981 is 533,065 x 10^6 BTU, which is the energy equivalent of 4,240,738 gallons of gasoline. The dollar value of this energy saving is on the order of $3.4 million to $4.2 million depending on the price per gallon for the quantities of fuels saved (gasoline, diesel fuel, No. 6 oil, aviation jet fuel). This saving equals 20 percent to 26 percent of the increased operating income in 1981 compared with 1980 as shown in Table 2-14.

The fuel efficiency of MBTA revenue vehicles translated into revenue vehicle miles per gallon of gasoline is shown to have increased from 1.02 to 1.14 from 1978 to 1981 (Table 2-14). By comparison, the average commuter automobile produces 15 vehicle miles per gallon of gasoline.

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*Information on energy efficiency was provided by the MBTA Office of Energy Conservation.

Calendar Year	MBTA Operating Income	MBTA Non-Operating Income	Total Assessment Upon MBTA Cities & Towns	Total State Financial Assistance	Total Federal Financial Assistance	Payments Made By Outside Cities & Towns
1971	$54,333,806	$ 5,152,722	$ 63,139,222	$17,896,842	-	$ 256,909
1972	54,966,090	4,872,019	75,554,063	19,196,304	-	361,418
1973	53,661,255	6,170,996	55,762,086	54,924,845	-	409,193
1974	52,879,664	10,667,444	69,779,097	58,919,886	$ 6,241,114	822,191
1975	52,693,955	11,724,241	73,123,805	73,876,432	11,172,532	1,003,701
1976	55,079,065	3,913,317	77,422,791	78,342,795	16,868,565	1,051,897
1977	55,437,432	4,579,221	84,142,099	85,178,488	22,200,066	1,384,148
1978	57,299,566	8,099,828	80,548,972	98,652,010	26,628,398	1,861,462
1979	58,991,159	13,650,718	82,067,271	112,604,709	27,422,397	1,968,721
1980	68,847,531	13,622,874	92,441,452	140,074,970	29,328,419	3,385,982
1981**	79,885,400	11,573,076	106,049,166	135,097,629	30,750,000	5,870,000

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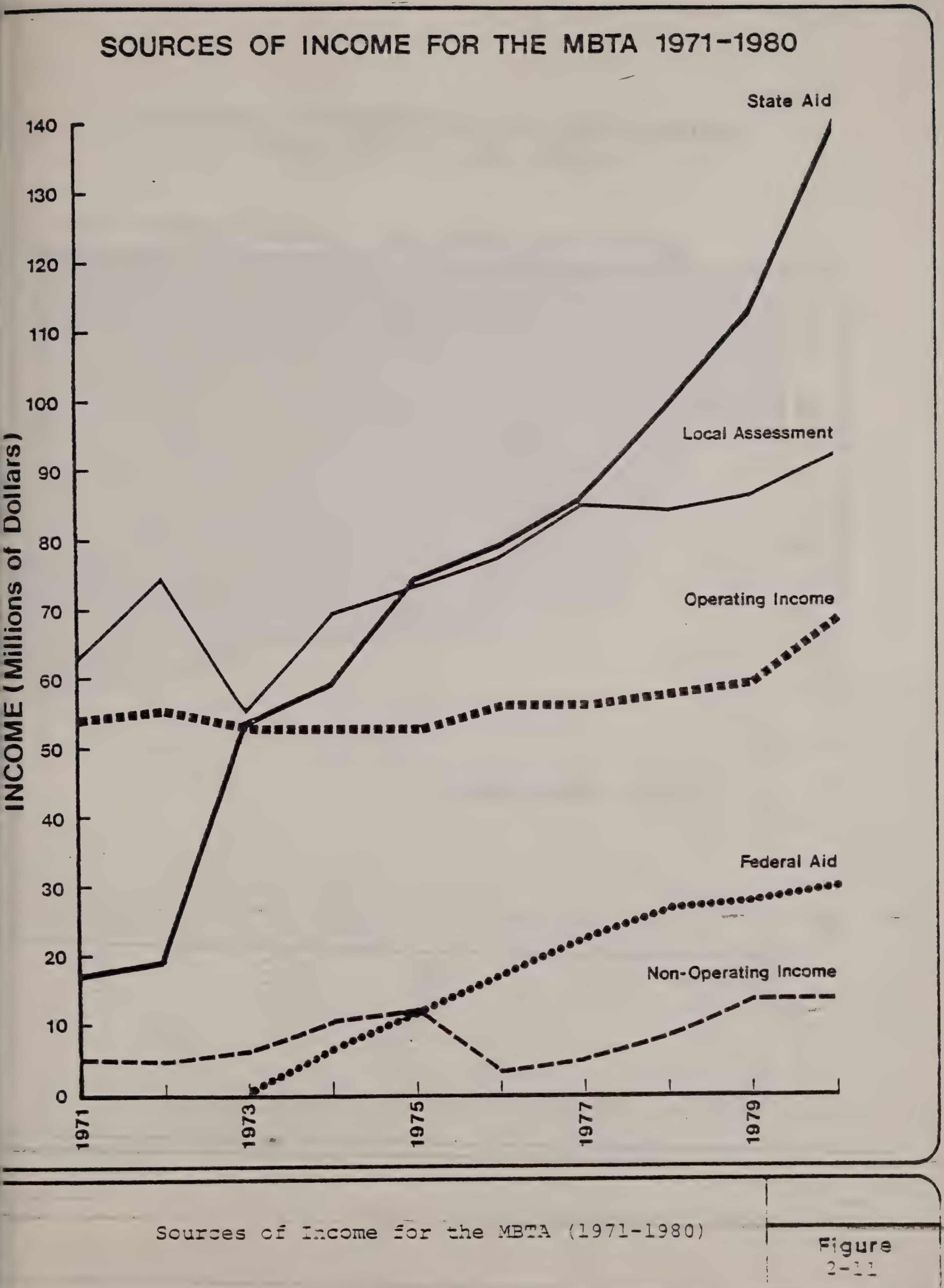
*All figures are rounded to the nearest dollar.

**Figures for 1981 are approximate.

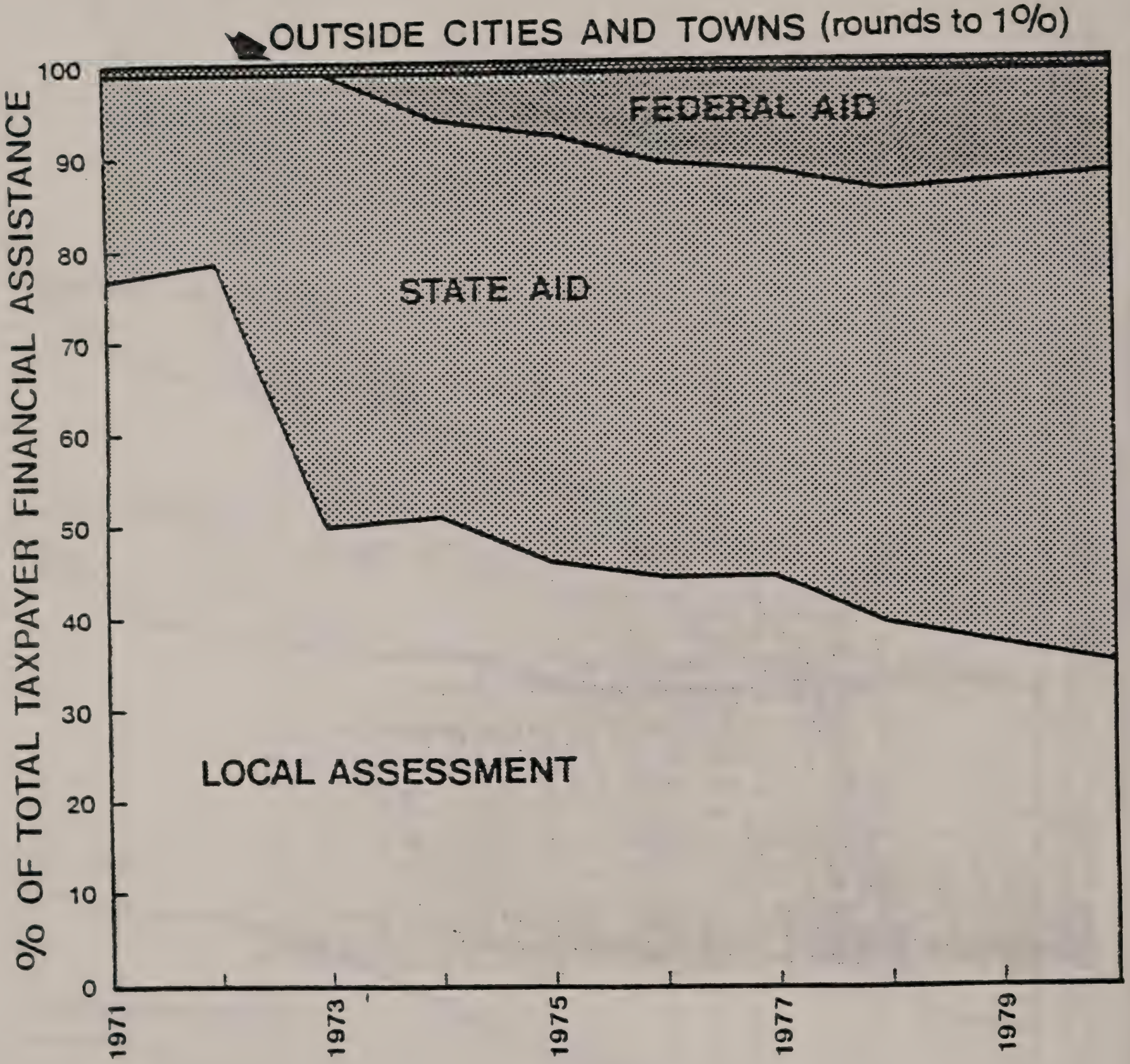
Sources: 1981 Current Expense Budget and Ancillary Data, 1980 MBTA Annual Report.



Sources of Income for the MBTA (1971-1980)

Figure 2-11

DISTRIBUTION OF GOVERNMENTAL FINANCIAL ASSISTANCE TO THE MBTA



Source: M.B.T.A. Office of Budgets and Operations Analysis

TRENDS IN GOVERNMENT FUNDING OF THE MBTA

Figur

2-1

Fuel*	1978	1979	1980	1981
No. 1 Diesel	975,376	973,550	971,310	921,679
Gasoline	60,487	59,466	55,417	48,643
Electric*	3,608,267	3,581,407	3,420,903	2,944,243
TOTAL	4,644,130	4,614,423	4,447,630	3,914,565
Fuel efficiency per revenue mile (miles/gallon equivalent)**	1.0283	1.0432	1.11956	1.14672
Fuel efficiency for total miles (miles/gallon equivalent)**	1.1185	1.1333	1.2192	1.2452
Revenue Miles	37,991,810	38,295,961	39,613,068	35,711,187
Rev. & Non-Rev. Miles (Total Miles)	41,325,273	41,604,191	43,139,771	38,778,065

Source: MBTA, Energy Conservation Office

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*Includes fuels used for transportation; electric use includes both transportation and non-transportation uses.

**Translates BTU's into equivalent gallons of gasoline (125,701 BTU's/gallon of gasoline).

TABLE 2-14

ENERGY USED BY THE MBTA - 1978-1981 (MILLION BTU'S)

The reasons for the relatively high energy use by MBTA vehicles compared with the average commuter automobile is caused by the unused capacity in transit vehicles, due to the predominant one-way flow of passengers in the AM and PM peaks and the concentration of ridership during these peak periods. Also, as noted previously, about 30 percent of the electric energy is used for wayside loads which are not directly related to moving vehicles. However, the more realistic measure of energy efficiency is in terms of passenger miles per gallon of fuel.

Using the 1981 figure of 4.29 passengers per revenue mile for the MBTA multiplied by the 35,711,187 revenue miles in 1981 (Table 2-14) produces 153,201,000 passengers. Assuming the average passenger trip length is 5 miles, the number of passenger miles becomes 766,005,000. Dividing the passenger miles by the fuel equivalent of 31,141,876 gallons of gasoline produces 25 passenger miles per gallon of fuel equivalent.

Assuming the average commuter automobile carries 1.4 persons, the energy efficiency becomes 21 passenger miles per gallon of fuel. This indicates that the energy efficiency of the MBTA transportation system is about 1.2 times the energy efficiency of the average commuter automobile. It should be noted that all of the MBTA gasoline and a portion of the diesel fuel are used in non-revenue vehicles. Therefore, this energy is not directly involved in moving revenue passenger vehicles. If the comparison of the energy efficiency of the MBTA and private cars were made during the peak periods and only the energy used to move the vehicles considered, the energy efficiency of the MBTA would be considerably greater.

In 1980, the Authority purchased 7,069,211 gallons of diesel fuel for buses and non-revenue vehicles. Assuming 296,200,000 passenger miles for buses, the energy efficiency is greater than 42 passenger miles/gallon since a portion of the diesel fuel is used in trucks.

What becomes evident here is that a large amount of energy investment made in the system as a whole results in high energy use per passenger mile when the system is being used at low capacity. However, there is a low marginal cost associated with the addition of increased ridership. For example, if the Authority increased revenue mileage by 10 percent to handle a 10 percent increase in ridership, the energy efficiency would be 4.4 percent greater than the total figure shown for 1981 since a large portion of the electric energy used by the system is fixed. In 1981, 29 percent of the total electric energy used by the system was consumed by non-traction loads, and this portion of the electric use would be unaffected by increased train mileage. Appendix F provides a sample calculation to show the effects of such a mileage increase on system energy efficiency.

2.7.2 Peak Load Factor Standards and Existing Conditions

In viewing energy efficiency factors and the quality of service provided by the system, an analysis of existing load factors on various routes is essential to determine both operating trends and short-term service planning. In 1977, as part of the Service Policy for Surface Transportation established by the MBTA, peak-load factor standards were created. These standards demonstrate a relationship between passengers per vehicle and seating capacity for time and type of service provision. The maximum load standards for surface travel are as follows:

Maximum Load Standards - Bus and Trackless Trolley Service*

Service Function	Peak 30 Minutes**	Total Peak Period	Midday	Evening
Linehaul	100%	100%	100%	100%
Feeder	140%	120%	100%	100%
Cross-Town	140%	120%	100%	100%
Inter-Town	140%	120%	100%	100%

Maximum load factor standards have not been defined in this manner for the rapid transit lines.

The existing load factors observed on the surface routes range from relatively low values (less than .50) on some suburban service at off-peak times to well over 3.0 on the rapid transit and trolley cars during the peak. The load factors by route for peak hours are provided in Appendix C-2. A notation has been made for each route where the load factor has increased since last year. The average peak period load factor for all bus routes combined was .99 in 1981, which compares with a slightly lower level of .97 in 1980.

2.7.3 Operating Capacities

Whereas load factors relate only to seating capacity on individual vehicles, the operating capacity of a system is estimated as a function of both the seating and standing capacity on vehicles (both surface and rapid transit) and the number of vehicles making runs. The effective operating capacity is less than the absolute operating capacity because of such factors as passenger flow, train flow, and spatial distribution of passengers on trains and in stations. For the MBTA rapid transit system, the signal system has also provided a design constraint.

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*MBTA, Service Policy for Surface Public Transportation, August 3, 1977.

**During 1981, the MBTA's standard was temporarily changed to 160 percent for all bus routes (during peak 30 minutes) as a budget reduction measure.

The theoretical operating capacity of the surface system is much less constrained by the current infrastructure and is principally determined by the number of assignable vehicles (1,025 buses and 50 trackless trolleys in 1981), the number of scheduled trips (7,121 daily in 1981), and the number of drivers available.

To estimate the current and potential theoretical operating capacity for the rapid transit system is more complex. Detailed in Appendix C-3 is a line-by-line description of this process for normal and crush loads under four different conditions:

1. Actual Capacity. Reflects the estimated line capacity given present service schedules.

2. Constrained Capacity. The number of passengers accommodated with the maximum amount of service which can be provided given the existing vehicle fleet.

3. Potential Capacity. The number of people that can be carried with an unlimited fleet and station modifications necessary to accommodate longer trains.

4. Design Capacity. The maximum capacity possible given the design limitations of the signal system and assuming absolute schedule adherence.

Table 2-15 provides a summary of this information for the rapid transit lines. A detailed explanation of the process and assumptions used to derive this information may be found in Appendix C-3, Operating Capacity.

	RED	BLUE	ORANGE	GREEN*O
Current Estimated Peak Hour Volume	15,000	6,000	7,000	7,000
Active Fleet (# of vehicles)	164	70	120	196
Constraint (85% of Active fleet)	140	60	102	168
Actual Capacity of Existing Operation (in passengers)				
Normal	12,716	5,091	7,173	6,221
Crush	16,592	6,432	9,117	7,972
Potential Capacity with Maximum Utilization of Existing Fleet				
Normal	16,157	7,480	10,013	11,562
Crush	21,082	9,452	10,760	14,300

*OHybrid vehicle was developed for purposes of calculation with a 2-car PCC/1-car LRV.

TABLE 2-15

CURRENT AND POTENTIAL OPERATING CAPACITIES WITH CURRENT INFRASTRUCTURE

3.0 RIDERSHIP IMPACTS OF RECENT FARE INCREASES

In response to the rising cost of operating the MBTA and restrictions on the funding levels, the Massachusetts Bay Transportation Authority increased fares and reduced service in recent years. These changes have already been described in Section 2.0 of this report. Actions of this nature have had a negative effect on ridership levels, causing passengers to seek other less costly or more convenient alternative transportation. The rider's response to changes in fares or service levels, quantified in terms of elasticities, depends on several factors including: the proportional change in the fare or service level; the trip characteristics such as sub-mode used (bus or rapid transit), time of travel or trip purpose; and the socioeconomic characteristics of the rider such as age or income and the cost characteristics of alternative modes.

This section presents a brief review of the literature on fare and service elasticities. The estimated ridership changes on the MBTA due to the recent fare increases are then presented. An elasticity analysis has been performed to estimate these changes, and an assessment of the usefulness of and problems with elasticity analysis is made.

3.1 ELASTICITY ANALYSIS AND RIDERSHIP RESPONSE

The ridership response to a change in either fare or service level may be quantified as an elasticity. Generally, elasticity analysis in economics is a measure of the responsiveness of consumers to changes in the price (fare) or the quality of a good (service). Here we are examining fare elasticity which is a static measure of the proportional change in a dependent variable (ridership) with a percentage change in price. Since the elasticity is found by computing the ratio of two percentages, it is a dimensionless number, meaning that its value does not depend on the units used for measuring demand and price.

For example, in this case, we are interested in discovering the price level at which riders will cease to use transit or will find alternative modes of transportation to be more attractive than using the transit service provided at a given cost. To do this, looking at the historic percentage change in ridership with each percentage change in fare or service may be useful. To quantify changes in levels of service in terms of the perceived value to riders is difficult. However, they may be derived by substituting a measurable value such as change in headway or frequency, etc.

Although there are several methods for calculating elasticities, the empirical elasticities referred to throughout this study are arc elasticities. An arc elasticity is defined as a percentage change in ridership based on a percentage change in price relative to the average of the before and after ridership and price values, respectively. It is defined mathematically as:

$$e_{arc} = \frac{(\,(q^2 - q^1)/(\,(q^2 + q^1)/2)\,)}{(\,(p^2 - p^1)/(\,(p^2 + 1^q)/2)\,)}$$

where q^1 = ridership before fare increase

where q^2 = ridership after fare increase

where p^1 = fare before fare increase

where p^2 = fare after fare increase

Thus, an arc elasticity is the ratio of the fractional change in actual demand (ridership, in this case) to a fractional change in price (the fare) here.

Service elasticities are derived in the same manner by substituting a measurable value for the change in the level of service, such as headway (service frequency) change.

For example, a review of the literature on fare changes in other cities has pointed to a range of elasticities that could be applied to Boston. Although this will be demonstrated in greater detail in Section 3.2.4, these are the ranges into which transit fare elasticities fall.

Peak Period

rapid transit = -.08 to -.36
local bus = -.17 to -.38
express bus = -.03 to -.33

Off-Peak Period

rapid transit = -.18 to -.44
local bus = -.26 to -.41

In general, the lower estimates are based on elasticities derived from Boston's past fare increases. For a review of elasticities, the reader is directed to two basic DOT publications.*

3.1.1 Review of Past Rider Response

Ridership response to changes in the transit fares and service levels has been studied extensively over the past 20 years. Difficulty arises, however, in trying to isolate the effects of just a fare increase or service change. A fare increase is typically coupled with a change in service, marketing technique or promotional campaign, making it difficult to determine the sole effects of a fare change. Other exogenous factors, such as a gasoline price increase or supply shortage, might obscure the effects of a fare or service change. Despite these problems, several basic conclusions have been drawn from previous experience. They are summarized below.

3.1.2 Fare Changes and Elasticity

- A general rule--the Curtin Rule-- that has been used by the transit industry in the past, states that for every one percent increase in fare, there will be a corresponding decrease of one-third of one percent in ridership. Although actual ridership response depends upon the particular city and circumstances surrounding the fare change, the use of this factor is still adequate for general systemwide estimates.

- Transit demand is inelastic with respect to fare; that is, a change in fares will cause a lower proportional change in ridership.

- Elasticities to bus fare changes are generally higher than rapid transit elasticities.

- Off-peak elasticities are generally higher than peak period elasticities. This corresponds with the responses of riders making work trips being less sensitive to fare changes than those making shopping trips.

- Empirical evidence does not generally support the theory that the relative response to a fare change depends upon both the absolute and proportional magnitude of the change. The elasticities derived using a relatively low base fare and a relatively minor increase should be transferable to other situations. Until recently, however, most fare increases have not typically been drastic, making it difficult to generalize as to the exact impacts of the 1980 and 1981 changes.

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*U.S. DOT, FHWA, Traveler Response to Transportation Systems Changes, 1981; U.S. DOT, UMTA, Patronage Impacts of Changes in Transit Fares and Service, prepared by Ecosometrics, Inc., 1981.

3.1.3 Service Changes and Elasticity

- Transit demand is inelastic with respect to changes in service, that is, a one percent change in a service characteristic (e.g., service frequency, vehicle miles) will produce a lower percentage change in ridership.

- Off-peak and weekend service elasticities are higher than peak period service elasticities.

- Ridership levels are more responsive to service changes on routes with lower levels of service than those with higher levels of service; for example, a reduction in service on a route with high headways (low bus frequency) would produce a greater loss in riders than a similar reduction on a route with low headways (high frequency).

- In general, ridership is less responsive to fare changes than to an equivalent percentage change in service, i.e., fare elasticities are lower than service elasticities.

- The impacts of service changes have most typically been measured in terms of the change in headways or vehicle miles of travel.

- Headway and vehicle-mile elasticities are similar, based on actual case studies. Aggregate vehicle-mile elasticities are considered irrespective of whether they relate to frequency, route length, route density or service-hour changes.

- Ridership is more responsive to improvements in headway than in-vehicle time. This conclusion is drawn from the results of bus priority lane demonstrations in several cities (including Boston).

3.1.4 The Results of Fare Increases in Other Cities

In a further attempt to summarize the general effects of a fare increase, a review of the effects of fare increases in other cities has been conducted. This review reaffirms the conclusions of Curtin (1968) that response to fare increase is generally inelastic, i.e., ridership change is proportionally smaller than the fare change. The following is a description of case studies of fare increases and their impacts on ridership in other cities.

New York State Metropolitan Transportation Authority (MTA)

An EIS prepared in May 1981 predicted a loss of ridership for proposed fare increases of 15 and 40 cents on subway and bus lines and 20 and 50 percent increases on commuter rail lines. The amount of fare increase, projected loss in ridership, and revenues are shown as follows.

Ridership and Revenue

Fare Increase	Ridership	Revenue
subway and bus 15¢ commuter rail 20¢	-5.0% to -6.7%	+16.6% to 18.3%
subway and bus 40¢ commuter rail 50¢	-13.4% to -17.8%	+37.6% to 43.5%

The report analyzed subsequent effects on vehicular transportation, air quality, economic activity, lower-income groups and related areas.

Transportation

Fare Increase	Increase in Daily VMT-Regionwide
subway and bus 15¢ commuter rail 20¢	+0.3% to 0.4%
subway and bus 40¢ commuter rail 50¢	+0.8% to 1.1%

Air Quality

Fare Increase	Auto Emissions - Regionwide	
subway and bus 15¢ commuter rail 20¢	hydrocarbons	+0.3%
	carbon monoxide	+0.7% to 1.0%
	nitrogen oxide	+0.2% to 0.4%
subway and bus 40¢ commuter rail 50¢	hydrocarbons	+0.7% to 1.0%
	carbon monoxide	+0.8% to 1.1%
	nitrogen oxide	+0.8% to 1.0%

The EIS concludes "the projected range of increased emissions for either HC or CO does not represent a significant impact to regional air quality." The EIS stated that the fare increase would have little impact on the overall level of regional economic activity, but conceded there would be a greater impact on lower-income groups. For example, an individual earning $10,000 annually would have to spend an additional 1 percent of his income if the fare were raised 15 cents. (An individual earning $20,000 would pay an additional 0.52 of his income). Negligible impacts were reported on noise levels, water quality, land use, and cultural resources.

Data from a 1980 fare increase were also included in the EIS. Fares on all lines were increased an average of 20 percent, with weekend half-fare and senior citizens half-fare programs reduced, along with service quality reductions. This caused a 5.7 percent decline in subway ridership during the last six months of 1980, and 9 percent and 11 percent declines in ridership reported for two bus lines. Other lines, including Conrail and the Long Island Railroad reported ridership increases of 3 to 4 percent.

A different study reported ridership reaction to the 1966 New York City subway fare increase in the following way:

Period of Day	Ridership Decrease
7 AM - 10 AM	2.4%
10 AM - 4 PM	8.0%
4 PM - 7 PM	5.0%
7 PM - 11 PM	14.6%
11 PM - 7 AM	3.7%

As is apparent from the chart, work trips showed the smallest ridership decrease, with more significant drops in off-peak hours when more discretionary trips are likely.

Ontario Cities Study

Following a series of fare increass in 24 Ontario cities from 1975 to 1977, a study revealed changes in ridership ranging from an increase of 14.7 percent to a decrease of 35 percent. The average ridership decrease was 1.1 percent. The average fare increase was 26 percent and different market segments, i.e., children, students, adults were subject to different levels of increase. Based on a six-month period following the fare increase, average revenues for transit systems rose 18.5 percent.

Other salient points of this example include:

- Only one of the cities experienced a revenue loss from increasing its fares.

- "The effectiveness of a fare increase in producing increased revenue decreases with the time elapsed since the increase. It appears that transit riders need some time after the fare increase before they can switch to other transportation modes or eliminate certain unessential trips or both."

An earlier Ontario study of 14 cities in 1976 examined ridership levels within three months of fare increases. For large cities over 200,000, the shrinkage ratio was about -.20; i.e., a 10 percent increase in fares resulted in a 2 percent reduction in ridership. For smaller cities, the shrinkage ratio was about -.33, or the same figure Curtin (1968) reached.

North Virginia Bus Routes

The effect of peak period fare increases on a series of bus lines running from Northern Virginia to Washington D.C., was reported in 1978. Trip distances varied from 5 to 16 miles, and patronage was seasonally adjusted.

Along a 5-mile route from Arlington to Washington, D.C., the fare was increased 52 percent. Subsequent ridership loss was 6.92 percent (elasticity - 28 percent). On the Falls Church to Washington line, a fare increase of 31 percent resulted in a ridership drop of 8.4 percent (elasticity - .27 percent). Along the 16-mile Shirley Highway Corridor, a 40 percent fare increase showed a 1.05 percent decrease.

The report observes that the longer Shirley Highway Bus route showed less elasticity with respect to transit patronage. The premium express service offered by the line appears less sensitive to price increase. A fourth bus line reported an increase in passenger ridership following an increase in fares. The report claims unidentified phenomena are responsible for this occurance.

The conclusion:

> There was little evidence of passengers on either service shifting travel outside the peak periods to avoid higher fares. The fare increase had no effect on auto travel. These results suggest applying different pricing policies to different types of transit service.

California Fare Increases

A report published in 1980 showed effects on ridership and revenue of fare increases in Los Angeles, San Diego, and the San Francisco-Oakland area.

The Southern California Rapid Transit District (SCRTD) carried 330 million riders in 1979 on 220 routes. Its basic fare was 40 cents, 20 cents additional for express, 10 cents additional for transfer, and 10 cents for seniors. In the spring of 1980, a fare increase raised the base fare to 50 cents, with "significant" increases in the cost of passes, and a 10 cent/stage increase on express lines. Ridership declined 6.7 percent, and revenue increased 22.1 percent.

The San Diego Transit Corporation (SDTC) carried in 1975 120,000 riders weekly. In August of 1978, its base fare was 40 cents, with 20 cents for seniors and 25 cents for youths. The fare increase raised the basic fare to 60 cents, off-peak senior to 30 cents, and express to 75 cents. As a result, ridership declined 20 percent, and revenues increased 41.6 percent.

AC Transit services Alameda and Contra Costa counties with trans-bay service from Oakland to San Francisco. On the average day, it carries 247,000 passengers. In 1978, its basic fare was increased from 35 cents to 50 cents, with "moderate" increases for trans-bay and express service, previously set at $1.25. Under the fare increase, ridership declined 9.8 percent, and revenue increased 43 percent.

Patronage, clearly, was more inelastic in Southern California and the Bay area than it was in San Diego. The report concluded that short-trip users were paying more, generally, in each California city studies and that staged or distance-based fares would be more equitable:

> Highly differentiated scenarios offer the greatest balance for modest patronage losses combined with significant revenues.

Baltimore

Zone fares were raised in Baltimore in March of 1976. Regular fares were increased from 30 to 35 cents (off peak) and 40 cents (peak hours) in addition to 10 cents/zone. Revenue increased an unspecified amount, while adult ridership declined. After a year's observation, the study revealed an elasticity level one-half of the accepted norm of Curtin (.33), or .165.

In conclusion, the studies observed have shown ridership to decline roughly one-third of one percent for every percent increase in fares. Few of the studies available have gone beyond observations of ridership declines. The New York State Metropolitan Transportation Authority's is the only report observed to include calculations for increases in VMT and subsequent air quality impacts. The EIS concludes that impact is minimal. The New York State EIR also is the only observed study that examines socioeconomic data to determine possible imapcts on lower- and moderate-income groups.

3.2 RIDERSHIP CHANGE FROM 1981 MBTA FARE INCREASE

A comparison of November 1981 and November 1980 ridership levels indicates that approximately 90,200 fewer trips were made on an average weekday in November 1981.* This translates into a loss of roughly 15.0 percent of the average weekday trips made on the MBTA. Of the 90,200 trips, it is expected that approximately 56,700 fewer trips (9.4 percent) were made because of the fare increase of August 1981. Service cuts accounted for a loss of 32,000 trips (5.3 percent) on an average weekday. In addition, it has been estimated that 1,500 of the trips (0.2 percent) were lost because of the bus replacement program in effect during track repairs on the Dorchester Branch of the Red Line. Other trips might have been lost due to deterioration of levels of service on the rapid transit lines. The ridership levels for an average weekday in November 1980 and November 1981 are shown by mode in Table 3-1. The ridership profile is also displayed.

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*The difficulty and uncertainty in estimating ridership on the MBTA is addressed in Appendix B.

The most significant changes in the types of riders were the increase in the number of elderly riders due most probably to the free off-peak fare, the increase in the number of pass users, and the decrease in the number of riders who pay the full adult cash fare. The smallest impact was on riders who use only rapid transit. The greatest loss was in the number of trips made using both rapid transit and bus for a single trip. A more detailed review of the procedure and results is provided in Appendix E.

Another way of presenting these changes is to illustrate the change in unlinked trips. This eliminates the uncertainty associated with linking trips; however, the number of unlinked trips is less meaningful because it is not directly related to a person-trip. That is, one linked trip made by transferring from a surface vehicle to a rapid transit line would be counted as two unlinked trips, one on surface and one on rapid transit. A single bus trip would be counted as one unlinked bus trip; a single linked trip where a transfer is made from one bus to another bus would be counted as two unlinked surface trips. The purpose of displaying the change in unlinked trips is to facilitate the derivation of fare elasticities and to isolate the effects of service changes. The percentage change in unlinked trips is very similar to that observed in linked trips:

	Nov. 1981	Nov. 1980	Percent Change
unlinked rapid transit	310,100	360,300	-13.9%
unlinked surface	422,100	507,000	-16.7%
TOTAL	732,100	867,300	-15.6%

3.3 ANALYSIS OF RIDERSHIP LOSS

Elasticities can be calculated from the change in ridership and fare levels using November 1980 and November 1981 levels to represent before and after conditions, respectively. The elasticities implied in the data for unlinked trips are as follows:

	# Trips (%) November 1981	# Trips (%) November 1980	Change (%)
rapid transit only	137,997(27.0%)	156,300(26.0%)	- 18,303(-11.7
combined rapid transit & surface	194,218(38.0%)	234,500(39.0%)	- 40,282(-17.2
surface only	178,885(35.0%)	210,500(35.0%)	- 31,615(-15.0
TOTAL	511,100(100.0%)	601,300(100.0%)	- 90,200(-15.0
adult - full cash	209,551(41.0%)	321,100(53.4%)	-111,549(-34.7
- pass	174,796(34.2%)	151,500(25.2%)	+ 23,296(+15.4
elderly & handicapped	62,865(12.3%)	46,300(7.7%)	+ 16,565(+35.8
student & children	44,977(8.8%)	59,500(9.9%)	- 14,523(-24.4
other free	18,911(3.7%)	22,900(3.8%)	- 3,989(-17.4
TOTAL	511,100(100.0%)	601,300(100.0%)	- 90,200(-15.0

SUMMARY OF RIDERSHIP LOSS FOR AVERAGE WEEKDAY
IN NOVEMBER

TABLE 3-

	e arc*
unlinked surface	-.32
unlinked rapid transit	-.48
TOTAL system unlinked	-.38

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*Uses ridership values as reported above; fare levels used were as follows:

	Nov. 1980	Nov. 1981
unlinked surface	21.8 cents	39.6 cents
unlinked rapid transit	42.4 cents	60.0 cents
linked total	43.5 cents	69.7 cents

These elasticities include the effects of both a fare increase and service reduction and, therefore, tend to be higher than those expected solely from a fare increase. An attempt was made to isolate the effects of the service reduction from the fare increase. The number of trips lost due to the service cuts was estimated using the percent reduction in service and a derived service elasticity.

The fare elasticities developed by adjusting for service reductions are presented below:

- unlinked bus trips: e arc = -.19

  assuming a 12.0 percent reduction in bus service resulted in a 7.3 percent drop in ridership;

- unlinked rapid transit trips: e arc = -.41

  assuming a .2 percent drop in riders due to the replacement bus service on the Red Line and a loss in the rapid transit portion of a combination trip because of the bus service cuts:

- total unlinked trips: e arc = -.27

The elasticities for buses appear to be more in agreement with the literature after adjusting for service changes. However, the rapid transit elasticities are still significantly higher than expected. This implies that other forces such as service reliability might have been acting to discourage ridership during this time.

The ridership response to changes in the reliability of service is hard to quantify. The MBTA measures the number of trips missed on a daily basis. The MBTA has set a performance level to meet 98 percent of all schedule trips. The increase in the number of missed trips over the last few years was used as a measure of reliability. Assuming that trips missed consistently would produce the same effects on ridership as service cuts, the change in the number of missed trips since the end of 1979 was applied to a service reduction elasticity to further adjust the fare elasticity on rapid transit. This procedure produced the following:

- unlinked rapid transit trips: e arc = -.36

  This is still somewhat higher than expected from previous experience. More reasonable estimates were obtained by using the composite effect of the 1980 and 1981 fare increases. The elasticity derived using pre-1980 fare increase levels are as follows:

- unlinked rapid transit trips: e arc = -.24

  Adjusting this for service changes would produce an arc elasticity of -.22. It appears that the combined effects of both fare increases on the rapid transit lines would explain the unexpectedly high ridership loss that resulted.

3.4 USEFULNESS OF ELASTICITY ANALYSIS

As can be deduced from the analysis just presented, a wide range of elasticities can be used to project the impacts of service or fare changes on ridership levels. Professional judgement must be applied to select the appropriate elasticities to evaluate a particular situation. In general, this type of projection is necessary to develop reasonable estimates for the revenue and ridership consequences of implementing a set of measures. It supplies a transportation provider with a quick and inexpensive analysis technique. For the purposes of comparing alternative strategies, elasticities are expected to be even more useful tools as it can be assumed that any bias present would be the same for each alternative.

4.0 ENVIRONMENTAL IMPACTS

The most significant environmental impacts that can result from a fare increase on the MBTA relate to changes in air quality and energy consumption. As the cost of public transportation increases and travelers stop using transit, they must either take some other mode of transportation for that trip or not make that trip. If passengers switch to either private automobiles or taxis, the total number of vehicle miles traveled (VMT) will increase, causing emissions and energy consumption to rise.

The magnitude of the air quality impacts can be estimated using an analysis method that considers three types of changes:

1. The change in the total regional VMT.

2. The change in congestion (queue length) on major Boston radial highways.

3. The change in traffic volumes at selected intersections designated as CO (carbon monoxide) Hot Spots in Boston.

The change in total regional VMT is of interest in order to ascertain potential impacts on the production of photochemical oxidants, a major component of smog. In general, as VMT increases, emissions of non-methane organic compounds (NMOC) and nitrogen oxides (NO_x) increase as well. Some of these compounds, particularly hydrocarbons (HC) and nitrogen oxides (NO_x), act in the presence of sunlight to produce photochemical oxidants.

As automobile use increases, congestion on facilities that are already crowded might worsen, causing increased queues, decreased speeds and, therefore, increased delays for all automobiles on that facility. This, in turn, leads to a greater increase in CO and HC emissions than would be anticipated based on VMT changes alone, because CO and HC pollutant emission levels increase as vehicle speeds decrease.

Congested conditions at major intersections might also be exacerbated by increased traffic volumes from diverted transit users. This also would lead to increased CO concentrations. CO, unlike HC, is a localized problem related to traffic at a specific location. Intersections where existing conditions have already created CO problems would be the locations most likely to be sensitive to CO increases that result from increased traffic volumes.

In order to estimate the magnitude of air quality impacts for this study, a determination of the increased automobile use resulting from the fare increase was made. This is described in the next section. Following that description, the air quality impacts will be estimated and analyzed. The relation to the state's air quality implementation plan (SIP) will be discussed. The energy and noise impacts will also be addressed.

4.1 ANALYSIS OF DIVERSIONS

The combined ridership loss due to the two fare increases of July 1, 1980, and August 1, 1981, was used to estimate the diversion to other modes and, hence, the air quality and energy impacts. It is estimated that a net decrease in daily passenger trips of 85,000 resulted since the end of 1979, due primarily to the fare increases over this time. Of these, between 55 and 65 percent of the diversions (46,750 to 55,250 trips) resulted from the 1981 MBTA fare increase. The 85,000 figure represents 42,500 round trips, of which 24,000 (57 percent) are peak trips and 18,500 (43 percent) are off-peak trips.*

The lost trips were divided into those made within downtown Boston, those within the core, excluding the downtown, and those core-bound trips originating outside the core from each of the six CTPS travel corridors. The core was defined as Boston and most of its immediately adjacent towns. Within each geographic category, the diverted transit trips were then assigned to alternative modes or trip-making behaviors. The alternatives were: taxi, automobile, commuter rail, private bus, walk/bike, other destination, and no trip. The percent of the travel in each category assigned to each mode is based largely on the relative accessibility of the alternative modes. Trip purposes, average trip lengths, automobile ownership, and other factors were also considered. Trips made by automobile or taxi were included in the estimate of increased VMT. Trips made to other destinations were expected to be made by automobile. A detailed description of the method and findings is provided in Appendix F-1.

4.2 AIR QUALITY IMPACTS

The Clean Air Act Amendments passed by the U. S. Congress in August of 1977 established health- and welfare-related standards for achieving air quality. These standards were established with two levels of attainment: primary standards (protecting human health) and secondary standards (those that prevent damage to property, materials, and vegetation). The State Implementation Plan outlines the steps that the state will take over the next five years to attain these federal air quality standards. Inventories of current conditions and forecasts of future emissions provide information for targeting the amount of emission reductions needed.

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*Although off-peak trips are generally more sensitive to fare changes, fewer off-peak trips were lost in this analysis, due to an off-setting increase in the number of off-peak trips made by the elderly. The proportion of total peak/off-peak ridership was considered in calculating the total of lost trips.

For the purposes of this report, these primary and secondary standards and areawide emissions levels were used as indicators of air quality impacts. Total predicted emission increases were compared to the standards for HC, CO, and NO_x. For lead, the fourth pollutant estimated, standards have not yet been established.

The possible health impacts of these pollutants were not analyzed separately but rather the established standards were considered to be adequate indicators of health impacts.

4.2.1 Regional VMT

Based on the estimated number of diverted trips, the choice of alternative transportation mode, the trip lengths, and the number of passengers per vehicle, the following increases in daily VMT are estimated:

• North Shore	18,800
• North	30,900
• Northwest	27,600
• West	30,900
• Southwest	25,400
• South Shore	51,800
• Within Downtown	9,600
• Within Core	35,100
TOTAL	230,100

The net result is, thus, an additional 230,100 daily VMT or approximately 70.6 million VMT annually. This represents an increase of roughly 0.5 percent of regional daily VMT.

The air quality impacts associated with the VMT changes reported above were estimated using EPA emission factors from their MOBILE2 program. The factors were selected based on the vehicle operating characteristics such as speed and operating mode temperature (cold/hot starts, hot stabilized), the characteristics of the Massachusetts vehicle fleet, and ambient temperatures. The basis for selecting these variables is described in Appendix F-6.

It is estimated that regional emissions associated with increased VMT increased by the following amounts due to the two recent fare increases.

• Non-Methane HC (NMOC)	191.3 tons/year
• Exhaust CO	2,929.2 tons/year
• Exhaust NO_x	242.6 tons/year
• Lead	4.7 tons/year

4.2.2 Air Quality Impacts - Highway Congestion

Additional highway congestion in the form of longer queues will occur due to higher traffic volumes. The greatest impact will be felt on the radial highways carrying commuters into Boston. These highways already carry significant traffic volumes and by adding traffic to these facilities, the queues will increase.

Increased queue lengths from the two recent fare increases have been estimated for morning and evening peak trips to and from Boston, respectively. The analysis uses an expressway queueing model, developed by CTPS, that predicts queueing delays based on daily traffic volumes relative to capacities at bottleneck points. The method is explained in Appendix F-3.

The additional automobile trips to Boston, identified in the diversion analysis, have been allocated to specific highways into Boston. These are identified in Table 4-1, for the AM and PM peak periods, along with the estimated increase in queue length. The changes in queue lengths range from just under 40 feet at the Sumner Tunnel during the morning peak period to almost 2,300 feet on the Southeast Expressway and Storrow Drive during the evening peak.

The larger changes in queue lengths are not due to extraordinary traffic changes, but rather due to the fact that these facilities do not have explicit queues. Since their base case queue speeds are faster, it takes a greater distance to generate a given amount of delay increase. It is expected that in actuality a queue of almost one-half mile would cause traffic to divert to alternate routes, such as Memorial Drive. It is likely that queues would not extend for more than one-quarter mile on either Storrow Drive or the Southeast Expressway. Larger queue estimates are shown to exhibit worst-case conditions.

The increased queues are experienced by all vehicles on these expressways during the morning and evening peak periods. Using EPA's MOBILE2 emission factors for automobiles, queue speeds reported in Table 4-1--and assuming that all automobiles in the queues are in the hot stabilized mode during the morning peak--the air quality impacts were analyzed. These are also shown in Table 4-1. The national averages for cold and hot starts were used in representing evening peak conditions.

4.2.3 Carbon Monoxide Increases - Intersection Impacts

An analysis of the change in CO concentrations at intersections designated by the Massachusetts Department of Environmental Quality Engineering (DEQE) as CO Hot Spots was undertaken as part of this EIR. A CO Hot Spot is an intersection which has high concentrations of CO. Five intersections were considered in this analysis based on a likelihood of increased emissions.

Increased traffic volumes were assigned to local streets based on the number of "within downtown," "core-to-downtown," and "corridor-to-downtown" trips generated by the fare increases.

AM Peak Period	Central Artery to I-93&Rt. 1	Storrow Drive to I-93 & Rt. 1	Sumner/ Callahan Tunnels	Southeast Expressway	Mass. Turnpike	Storrow Drive
Increased Traffic	3,195	1,220	370	3,650	3,160	1,070
Free Flow Speed	50 mph	40 mph	40 mph	55 mph	55 mph	40 mph
Average Queue Speed	10 mph	5 mph	5 mph	25 mph	55 mph	25 mph
Change in Miles of Queue	0.12	0.037	0.007	0.214	No Change	0.20
Peak Volume	11,525	8,080	10,495	26,584	16,250	10,875
*Additional HC Emissions	1.43	0.69	0.17	2.41	-	0.83
*Additional CO Emissions	25.82	13.09	3.14	38.52	-	14.72
*Reduction in NO_x	0.41	0.07	0.02	1.38	-	0.52

PM Peak Period	Central Artery to I-93&Rt. 1	Storrow Drive to I-93 & Rt. 1	Sumner/ Callahan Tunnels	Southeast Expressway	Mass. Turnpike	Storrow Drive
Increased Traffic	2,740	1,675	370	3,655	3,160	1,070
Free Flow Speed	50 mph	40 mph	40 mph	55 mph	55 mph	40 mph
Average Queue Speed	10 mph	5 mph	5 mph	25 mph	55 mph	25 mph
Change in Miles of Queue	.25	.905	.0211	0.435	-	0.43
Peak Volume	11,525	8,080	10,495	26,584	16,250	10,875
*Additional HC Emissions	4.04	2.15	0.48	4.64	-	1.87
*Additional CO Emissions	92.81	52.75	11.68	109.79	-	44.40
*Reduction in NO_x	1.20	0.24	0.05	3.64	-	1.47

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*Tons/Year.

SUMMARY OF IMPACTS OF INCREASED QUEUES

TABLE 4-1

These trips were allocated to super zones as defined by the 1977 Central Artery Origin-Destination Study. Volumes were then distributed to the five intersections being analyzed based on likely travel routes.

The CO Hot Spot Analysis technique used was EPA's Volume 9 method as modified by DEQE. The technique considers traffic characteristics such as volumes, intersection configuration, signal timing, speeds, meteorological conditions, and dispersion rates. Worst case urban meteorological conditions of low wind speed, low vertical mixing, and neutral air mass stability are assumed. The receptor site is located on the approach with the longest traffic queue and is situated at the point along the queue where the worst-case, wind-roadway angle will produce maximum impact from this queue's emissions. All traffic on an intersection approach is assumed to be divided equally among the available lanes; hence, all lanes on an approach will develop queues of equal length.

The procedure computes emissions both from vehicles that travel through the analyzed location without delay and from those that are delayed and, therefore, generate emissions at a higher rate. These "free-flow" emissions and "excess" emissions are added to the areawide background concentration to derive the CO concentration at the location.

Employed to estimate both eight-hour and one-hour concentrations of CO, the model was used to estimate conditions with and without the fare increases. The results of the analysis are shown in Table 4-2. (A description of the CO Hot Spot Analysis parameters is provided in Appendices F-5 and F7.)

None of the intersections exceed the one-hour standard of 35 ppm, although conditions at Leverett Circle approach 30 ppm. The most notable changes were projected at the intersection of Cambridge and Staniford streets (+4.8 ppm) and on Beacon Street at the Embankment Road (+2.75 ppm). The eight-hour standard of 9 ppm would be violated at three intersections with the increased traffic volumes, according to the analysis. Both Leverett Circle and the Boston University Bridge sites exceeded the levels before the fare hikes. Conditions along Blue Hill Avenue would deteriorate to the point where the standards would be exceeded at the designated intersection.

4.2.4 Atmospheric Lead Level Impacts

An effort was made to estimate the amount of lead emissions from automobiles attributable to the fare increases. According to a number of sources the amount of auto-caused, lead-particulate emissions is dependent on a range of environmental and vehicle-operating conditions, including: vehicle speed, driving conditions, lead content in gasoline (which itself can vary by season, region of the country, and grade of gasoline), quantity of gas consumed, fuel economy, mileage accumulation, and distance traveled. Other factors having an effect on atmospheric lead

	8-HOUR (ppm)			1-HOUR (ppm)		
tersection	Without Fare Increase	With Fare Increase	Change	Without Fare Increase	With Fare Increase	Change
verett Circle peak +180 vph 8-hour +105 vph	10.85	11.43	+.58	29.31	29.75	+0.44
mbridge & Staniford Sts. peak +205 vph 8-hour +118 vph	7.56	8.22	+.66	16.17	20.97	+4.80
ue Hill Ave. & American gion Hwy. peak +100 vph 3-hour +60 vph	8.87	9.17	+.303	21.01	21.77	+0.76
J. Bridge & Commonwealth Ave. peak +90 vph 3-hour +50 vph	9.79	9.79	+.00	27.73	28.33	+0.60
acon St. & Embankment Rd. peak +80 vph 3-hour +47 vph	8.57	8.64	+.07	23.39	26.14	+2.75

ı = vehicles per hour
n = parts per million
igures include a background CO concentration of 3.0 ppm.

CO ANALYSIS* (1982)

TABLE 4-2

emissions are, of course, orientation of the prevailing winds and additional non-auto sources, such as industrial processes from smelting to the production of Portland cement, residential fuel combustion, and dust from roads and tilled land.

A certain amount of controversy surrounds the actual amount of atmospheric lead contributed by automobiles. A report from EPA puts the figure at 90 percent. Although there is some debate about that figure, most studies do agree that the amount of lead emissions is steadily dropping as the number of vehicles using leaded gasoline declines. EPA claims there has been a 400 percent decrease in the calculated lead emission factor from 1975 to 1982 and another 730 percent reduction will take place before 1990.

Using a method which takes into account vehicle mix, fuel consumption, lead content of gasoline, and the amount of lead emitted from vehicles, an estimate of vehicular lead emission in the Boston area has been developed. It is keyed to the estimated increase in vehicle miles traveled regionally. An increase in VMT of 230,100 will add approximately 34 pounds of lead to the region's atmosphere daily, or approximately 4.67 tons per year. This can be further categorized by subregion (see below) using grams/vehicle mile multiplied by a factor of .0676.

Area	Daily VMT	Grams of Lead
North Shore	18,800	1,270.88
North	30,900	2,088.84
Northwest	27,600	1,865.76
West	30,900	2,088.84
Southwest	25,400	1,717.04
South Shore	51,800	3,501.68
Within Downtown	9,600	648.96
Within Core	35,100	2,372.76
	230,100	15,554.76 = 34.3 lbs.

Given the amount of variability in vehicle condition and environmental factors, this should be treated as a rough estimate of lead emission. it is also based on a vehicle mix and fuel economy standards of vehicles from 1961-1980; we may assume that 1981 and 1982 model vehicles have reduced lead emission and that more old, lead-fueled vehicles have been taken off the road.

Another factor which has not been determined, but which could be considered, is the effect of "re-entrained" road dust containing lead which is disturbed by passing vehicles. EPA states this figure would be under .01 grams per vehicle mile by 1980 and further decreased by 1982 due to reduced use of leaded fuels. Appendix F-6 includes information on the way these figures were calculated.

4.2.5 Relation to Air Quality Standards

As already mentioned, localized CO conditions are expected to deteriorate as a result of additional automobile travel due to the fare increase. The eight-hour standards would be exceeded at three of the five intersections studied. One of which would be due directly to the added impact of the fare increase. These should, however, represent the most significant changes in the CO concentrations in the region, due to the fare hike.

It has also been shown that emissions of hydrocarbons will increase, due to both increased VMT and congestion. DEQE has estimated the expected annual emissions of HC in the Boston region for 1982 and has identified the target reduction to bring the region in compliance with the National Ambient Air Quality Standards. Currently, the region is exceeding the standard; the fare increases exacerbated the situation by adding hydrocarbons at the rate of 200 tons per year.

The State Implementation Plan, which outlines the steps the state will take over the next five years to attain the air quality standards, is currently being revised. The Transportation Element of the SIP (TE/SIP) for the Boston region is required to indicate how the region will reduce emissions to reach the target reduction identified by DEQE. The increase in emissions due to the fare increases is less than half of one percent of the reduction needed by the transportation sector to attain the standards.

For the Boston SIP analysis area, a 35-percent reduction in 1980 emissions is required to assure compliance with ambient air quality standards.

The NMOC (HC) emissions inventories for the Boston analysis area indicate that there will be a 39-percent reduction in 1980 emissions by 1987 if all controls spelled out in the 1979 TE/SIP are implemented as presently scheduled, including Inspection and Maintenance (I&M), all stationary controls, and the Federal Motor Vehicle Emissions Control Program Emissions for 1987 for the MAPC region are estimated at 39-percent below that of 1980.

However, this margin of the announced attainment level without additional controls is narrow. The fare increase further narrows this margin. Should this margin hold, it is important to note that simply balancing on the edge of attainment, while meeting requirements, would act as a constraint on the region's future growth.

The state's ability to accept additional pollution from future industrial or transportation sources will be limited if attainment is narrowly met. Therefore, whether the state is at or below attainment, the TE/SIP's emission reductions, combined with the proposed additional SIP reductions, will act to improve the state's position regarding attainment and growth.

These results indicate that the Boston urban area, as well as the MAPC region, will be in compliance with air quality standards by 1987 if all controls spelled out above are implemented as scheduled.

Any added reduction resulting from transportation control measures to be implemented will increase the margin by which the region will be in compliance.

4.3 ENERGY IMPACTS OF THE FARE INCREASE

There are numerous energy consumption impacts in the diversion of riders from transit to private automobiles on both a primary and a secondary level. Initially, assuming an average auto energy efficiency of 15 miles per gallon and an estimated increase in VMT of 69 million miles per year, motor fuel consumption would increase by 4.6 million gallons/year, due directly to the fare increases. This represents approximately 0.2 percent of the annual motor fuel consumption in the state.

While there would be a passenger reduction on the MBTA, it is questionable whether significant energy or fuel savings could be realized by the MBTA. This is due to the fact that even a significant reduction of riders would not affect the fixed energy usage (29 percent of total usage) required to operate the entire system and would not have an effect on total vehicle mileage unless new schedules were implemented to reduce unused service.

It should be noted that the changes in air quality or energy consumption do not consider that the reduction in riders might cause reduced bus VMT. In fact, the number of bus miles operated by the MBTA has been decreased, and this is attributed to rescheduling and service decreases previously planned and not directly related to the fare increase.

This analysis has attempted to isolate the impacts of fare increases and so reduced bus VMT is not considered. Secondary, energy impacts are also anticipated: the traffic congestion resulting from diversions will increase the original yearly estimates of additional fuel consumption by 11 to 15 percent. Appendix F-3 details the increases in energy use. In the analysis presented there, it is concluded that the congestion would require an additional 689,000 gallons of fuel per year. This would produce a total increase in motor fuel consumption of approximately 5.4 million gallons per year.

4.4 NOISE IMPACTS OF THE FARE INCREASE

Generally, noise pollution is a highly localized problem and, as such, the fare increases on the MBTA should have a negligible impact on noise levels. The increase in traffic volumes at a given location is not large enough to create a noticeable change in the noise levels. Noise is measured on a logarithmic scale to replicate changes discernible by humans. It would take a doubling in the traffic volumes to produce a noticeable change in the noise levels heard. The increased volumes are not of this magnitude.

This, however, assumes that the diverted drivers remain on the same paths currently used. It is probable that increases in traffic congestion would change circulation patterns and divert some additional trips through local streets, thus increasing noise levels in some local areas. A much more detailed network modeling effort would be required to simulate all probable intersections which would be impacted.

Since vehicle noise is also a function of speed, congested conditions might also change perceived noise levels. Noise levels generally are lower for automobiles at lower speeds; truck noise levels increase at lower speeds. No attempt has been made to quantify these effects, since heavy trucks comprise a small percentage of vehicles in the queues.

5.0 ALTERNATIVES

This section identifies and analyzes several alternative actions to the fare increase that could be taken by the MBTA. The No-Action alternative presents the case that would have occurred had a fare increase not been granted. The Implemented Action represents the fare increase of August 1981. In most cases, the impacts of the fare increase have been isolated from those associated with service cuts, which also occurred in 1981. Several alternative fare structures have also been presented including peak period pricing, discounted transfers, and reduced rates for certain groups. Alternative fare payment methods have also been addressed.

Following the discussion of the individual fare alternatives, a comparative analysis is presented.

5.1 NO-ACTION ALTERNATIVE

For the purpose of this EIR, the no-action alternative maintains fares at pre-August 1981 levels. According to an estimate presented in the Environmental Notification Form (ENF), July 7, 1981, an additional $19 million was needed to get through 1981 without further service reductions. Increasing the fares was cited as the only feasible way of raising the necessary funds. The MBTA stated that if a fare increase were not implemented by August 1, 1981, serious repercussions were inevitable. The two possible results of inaction cited in the ENF were: a reduction of all service levels shortly after August 1; or, the termination of all service for approximately the months of November and December. The latter situation would have severe impacts on both users and on-users of the MBTA.

At that time, the MBTA did not further detail the extent of the service cuts needed to maintain some service throughout the remainder of 1981. The Authority has since then identified the types of changes that would be necessary to comply with a budget level $15 million short of what it needs. These are described in Section 5.2 as part of the Implemented Action. Generally, the MBTA would have to cut bus routes, reduce maintenance personnel, reduce rapid transit service, and modify some employment practices concerning part-time work.

If the August fare increase had not been implemented, the 1982 budget shortfall would have been approximately $35 million over the 1981 level. In other words, more changes would have been needed at the MBTA to reduce service and associated personnel costs by $35 million. Since over one-third of all costs are fixed, the reductions would have had to affect service.

5.2 IMPLEMENTED ACTION

Implemented actions included the August 1981 systemwide fare increase coupled with changes in the level of transit service. Local bus fares increased from 25 cents to a zonal system with a 50 cent base fare. The base rapid transit fare rose from 50 cents to 75 cents. Express bus fares were incresed to a maximum of $1.50/trip. Service reductions in the form of cancelled routes, shortened routes, increased headway, reduced hours, and decreased express bus service were instituted.

A detailed description of these actions was presented in Section 2.0 of this report; the impacts on ridership and the environment were addressed in Sections 3.0 and 4.0, respectively.

5.3 ALTERNATIVE FARE STRUCTURES

This section presents a series of alternative fare structures for the MBTA. In general, these alternatives are directed toward increasing revenue or ridership associated with specific groups of users. The programs identified would affect commuters, senior citizens, low-income riders, or other target groups depending upon the alternative action.

In each case, the alternative is described and past experiences with the programs, either in Boston or in other cities, are reviewed. Where possible, the likely impacts of these actions on ridership and revenue are quantified. The feasibility of implementing the alternatives and the operational and equipment changes needed on the MBTA are addressed.

5.3.1 Peak-Period Pricing

Peak-period pricing is simply the policy of maintaining lower transit fares during off-peak hours (generally 10 AM to 4 PM and after 7 PM on weekdays and all day Saturday and Sunday) than during peak hours. Such systems may be implemented by either lowering off-peak fares or raising peak fares. These pricing policies are sometimes applied only to certain groups within the general population, most frequently to the elderly.

Many systems throughout the country have experimented with peak-period pricing, although few large systems have maintained such fares.* The impact of these policies on ridership differs

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*Dygert, Holec, and Hill, Public Transportation Fare Policy, for USDOT, (Washington, DC: Peat, Marwick, Mitchell and Company) December 1976.

Alternative Fare Structures	Description of Measures
• Peak Period Pricing	Raise fares during peak hours for all full fare riders.
• Reduced Rates for Transfers	Examine the viability of reduced rate transfer system for the approximately 40 percent of all MBTA trips which require a modal change.
• Lower Fares for Downtown Travel	Reduce fare within the core area in an attempt to increase ridership on trips currently made by other modes.
Alternative Fare Payment Methods	
• Electronic Fare Collection	Through the use of electronic equipment, tickets can become credit towards a certain amount of transit service. A more diversified fare structure could also be established and administered.
• Bulk Sale of Tokens	Reduce the cost for riders buying tokens in bulk to aid in reducing lines at token booths and to provide incentive of a discount for regular riders for whom passes are impractical.
• Self-Service Fare Collection	With the assistance of automated ticket dispensing equipment and inspectors doing spot checks on riders, much of the personnel costs involved in the current fare collection could be eliminated.

TABLE OF ALTERNATIVES

TABLE
5-1
1 OF 2

Legislative Programs

• Subsidy Programs	The current "less than full" fare categorical discounts for special groups (i.e., students, elderly, handicapped) would be administered by social service agencies and school district so that costs of subsidy would be assigned more equitably and that policies for the granting of subsidie could be established to prevent abuse.
• Alternative Funding Programs	To find ways of generating funds from other sources tha the current mix of governmen tal and revenue sources, including sales tax, gas tax and auto use charges, and payroll taxes.
• Cost of Living Indexing	Establish a policy in which the fare is tied to cost indices with regular adjustment periods.

widely from one city to another. Austin, Texas, decreased off-peak fares by 50 percent, and ridership increased 30 percent. When Louisville, Kentucky, did the same thing, ridership increased only 7 percent.* Madison, Wisconsin, offered free off-peak rides for one week, and ridership increased by 93 percent.

The primary goal of peak-period pricing is to increase ridership during off-peak hours. When fares are increased systemwide, the impact is felt most strongly during off-peak hours when traffic congestion and vehicle crowding are already at their lowest. By instituting a system in which off-peak fares are lower, new riders may be attracted, and those already using the system may be induced to switch from peak- to off-peak travel. These results were measured in two cases of off-peak reduced fares in Denver and in Trenton.

In Denver, the off-peak fare went from 25 cents to free; the peak fare had increased from 35 cents to 50 cents just prior to the demonstration.** These changes resulted in an 87 percent increase in off-peak ridership and a 24 percent decrease in peak ridership. Net ridership increased 34 percent. In Trenton, off-peak trips became free (from 15 cents), and peak fares remained at 30 cents. The result was a 45 to 50 percent increase in off-peak travel, an 8 percent decrease in peak travel, and a net ridership increase of 10 to 15 percent. Therefore, both of these programs increased ridership as well as shifting some riders from peak hours to less crowded off-peak hours. The concomitant decreases in revenue have not been documented.

Another approach to reduced off-peak fares is to lower fares on weekends. In 1974, the "Save on Sunday" program was instituted in New York City. The program offered two rides for the price of one on Sundays only. Sunday ridership increased by approximately 37 percent overall.***

In general, peak-period pricing policies are fairly simple to implement. No investment is required from the transit facility outside of that required to launch a public information program informing riders and potential riders of the change. The obvious major drawback of reducing off-peak fares is that it necessarily requires a decrease in net transit revenue. A study of six transit systems in New York by NYSDOT concluded that no combination of fares could increase both revenue and ridership.* They also found that no combination of fares on the NYC subway will increase ridership by 2 percent without cutting revenues by at least 6 percent. (The study group also warned that ridership losses are not reversible; it is best to encourage different fare policies that decrease ridership by no more than 5 percent because lost riders are difficult to win back.) Thus, while any reduced fare program will undoubtedly stimulate ridership, a significant loss in revenue must be expected as well.

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*Goodman and Green, Low Fare and Free Fare Transit, for UMTA (Washington, DC: Peat, Marwick, Mitchell, and Company) December 1976.

**Barton-Aschman Associates, Incorporated, Traveler Response to Transportation System Changes, Second Edition, for FHWA (Washington, DC: Barton-Aschman Associates) July 1981.

***Mayworm, Lago and McEnroe, Patronage Impacts of Changes in Transit Fares and Service, for UMTA (Washington, DC: Ecosometrics, Incorporated) September 1980.

The Boston Experience

The MBTA has had some experience with peak-period pricing in its Dime Time Experiment. In April 1973, fares on the Blue, Red, and Orange lines, as well as the Central Green Line, were reduced from 25 cents to 10 cents between 10 AM to 1 PM on Monday through Friday. The fare on the Red Line Extension to Quincy was reduced from 50 cents to 25 cents. In March of 1974, Dime Time was extended to include an extra hour on weekdays (until 2 PM) and all day Sunday. The experiment was terminated in August 1975. A study by Decision Research, Incorporated, in 1974, was unable to quantify any gain in ridership.**

While Dime Time did cause some shift in ridership from the peak to off-peak period, total ridership remained relatively level (+2 percent).

The elderly, as a group, are sensitive to change in fare. During the period in which Dime Time was in effect, the elderly were paying one half the adult fare of 25 cents. Dime Time represented a minor fare reduction for this market segment. Starting in August of 1981, the elderly have been allowed to ride free in the period between the AM and PM peaks. This absolute reduction in fare has created a substantial gain in elderly ridership.

Reduced off-peak fares for the elderly are offered by most transit systems in the United States. The federal government requires these fare reductions in order to qualify for Section 5 funding. Lower fares for those 65 and over who reside in the MBTA district are required by law. As of August 1969, Chapter 161A of the General Laws required that elderly riders pay no more than one half the full adult fare on both subways and surface lines.

Impact of Off-Peak Fares for the Elderly

Since August 1981, elderly and handicapped riders have been able to use the system for free between 9:30 AM and 4:00 PM on Monday through Friday. This policy increases the number of elderly riders and decreases revenue for the MBTA. The cost of this program is equivalent to the dollar value of the fares not paid by elderly riding for free.

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*Hartgen and Weiss, "Different Time of Day Transit-Fare Policies: Revenue, Ridership, and Equity" in Transit Planning and Operations, Transportation Research Board Record 625 (Washington, DC: Transportation Research Board) 1977.

**Decision Research Corporation, Dime Time Ridership, Study No. 2 for MBTA (Wellesley Hills, MA: Decision Research) June 1974.

About 59,000 elderly riders use the system on an average weekday and pay over $9,000. If all of these riders paid half fare, the receipts would total about $25,000 per day. The difference, however, does not accurately represent the value of the lost revenue, because the fare would cause some riders to leave the system. No data is available regarding the response of elderly riders to new fares after a period of free fares. One might expect, however, that the new ridership level would be similar to that which would have occurred had fares for the elderly increased in August when the other fares did, without an intermediate period of free fares. Using the 1980 elderly ridership (approximately 45,000/day), the old fares, assumed new fares (equal to one half of adult fares), and an elasticity of 0.14, an expected ridership level of about 32,000 people per day can be calculated.

It, therefore, seems likely that if fares for the elderly had increased to one half of the new full adult fare, there would be approximately 32,000 elderly riders per day paying about $14,000. This means that the free fare program costs about $5,000 and increases ridership by the elderly by 27,000 trips each day. These values translate into a net annual loss of $1.6 million and a gain of about 8 million riders.

Finally, a peak period pricing strategy that bears consideration is one of raising fares during the peak hour. This policy would take advantage of the low fare elasticities exhibited by riders en route to or from work during the peak hour. Since it costs more to carry passengers during peak hours and since peak period riders often place a higher value on their trips than off-peak passengers, these riders are good candidates for increased fares.

In order to estimate the impact of such a program on MBTA ridership and revenue, several assumptions must be made. First, assume that the fare policy adopted required a "peak-period premium" of 10 cents on each ride (a fare increase of about 15 percent). Further, assume that 57 percent of all transit trips are made during the peak periods and that an elasticity of 0.16 (Ecosometrics) is applicable to these trips. Therefore, a 10 cent peak-period premium would result in an annual loss of almost 2 million riders and a net gain of nearly $6.5 million. If, however, the diverted riders simply shifted from peak to off peak, thus avoiding the surcharge, no riders would be lost and revenue would increase by about $7.8 million. The actual result of an increase in peak-period fares should fall somewhere between these two figures.

5.3.2 Reduced Fare Strategies for Special Groups

Offering a reduced fare to a group of riders will generally have two effects. First, it will decrease the amount of revenue collected from each individual and from the group as a whole.

Second, it will stimulate ridership, increasing patronage of the system by members of the group.

The policy of establishing modified fares for certain groups of riders can be justified in several different ways. Many transit properties offer reduced fares to groups that are considered less capable of paying high fares, such as the elderly or the handicapped. Others offer low fares meant to encourage trips that are felt to contribute to the "public good," such as school trips by students. Also, many transit properties seek to take advantage of the lack of responsiveness of certain groups to fare changes. Some groups, commuters for example, have such an inelastic demand for transit that by raising their fares, system revenue can be increased significantly without causing a major disruption in ridership.

In order to evaluate reduced fare policies, potential methods for defining these groups of riders must be examined. The effect these policies would have on the transit system in Boston can only be estimated for those cases for which local data is available and experience in other cities has been documented.

An obvious criterion by which transit riders may be divided is age. Senior citizens enjoy reduced fares in most U.S. cities and towns; in Massachusetts, such a policy is required by law. The effect of reduced fares for the elderly is described in the preceding section of this report (see Section 5.3.1).

Another age group frequently singled out for special fares is children. Low fares are justified both by virtue of the limited funds available to children and because many trips made by children are school trips. School trips are popularly considered to merit some form of subsidy. The exact number of transit trips being made by students and children in Boston is unknown. A recent CTPS estimate places the number at approximately 12 million trips per year. The trips bring in slightly over $4 million each year. If students were forced to pay full fare for these trips, it is estimated that the number of student trips would fall to close to 9.5 million per year with a total revenue of close to $8 million. This represents a loss of over 2.5 million student trips with a concomitant gain of $4 million.

One of the few studies of the travel behavior and travel needs of young city residents was done in 1968 by Carnegie-Mellon University.* The study analyzed travel patterns and travel desires of 7th, 10th, and 11th graders at five Pittsburgh high schools with student bodies of varying socio-economic status and racial composition. The study revealed that:

(1) The 'typical' student makes four trips a day between 3 nodes that are a mile apart;

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*Latent Demand for Urban Transportation, Transportation Research Institute, Carnegie-Mellon University, Pittsburgh, PA, 1968.

(2) younger students travel less frequently, within a smaller urban area, and to fewer destinations than older students;

(3) female students travel less frequently, within a smaller urban area and to fewer destinations than males (except for 7th grade females);

(4) non-whites travelled further but within a smaller urban area than whites;

(5) the 'typical' student desired to make, on a typical weekday, two additional trips (i.e., two more than he now makes).

If one were to accept the results of this study, it is clear that urban youths use transit systems and desire to use the transit system for more than just school trips: for work, sports, social engagements, etc. It should be recognized that for some urban youths, the MBTA is the only transportation alternative. Unfortunately, the data is not sufficient to predict the effect of 1/2 fare for children under 18 at all times.

There are, however, two experiments of free-fare transit* at all times which had results that may relate to reduced student fares. The transit systems of Denver and Trenton reported significant increases in rowdyism and vandalism on transit vehicles and at stations when the free-fare system was in effect. The most surpising result of the Trenton project according to a report, "was a groundswell of driver and media reaction to an increase of rowdiness, vandalism, and harassment on the buses and in a suburban shopping mall served by the demonstration's free rides." Trenton's response was to increase security forces and reduce the free hours. Similar events took place in Denver, where reports of disruptive incidents correlated with the free-fare period. This is not to suggest that half-fare for those under 18 at all times would have a similar effect in Boston, but it is a subject for further study.

Another group that might be considered eligible for reduced transit fares is low-income riders. Although transit riders with low incomes are generally fairly unresponsive to fare increases (their demand is inelastic), this is frequently due to the fact that they are often captive riders as well. When low income riders are forced to pay more to use the transit system, they increase the already disproportionately large fraction of their income that must be devoted to travel expenses. The effect of subsidizing transit ridership for low income users in Boston is difficult to measure. Lack of information regarding the incomes of transit users and the general travel patterns of the poor presents a major obstacle. The presence of large numbers of college students in the Boston area also compounds the problem of the definition of low income.

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*A. H. Studenmund, "Interim Analysis of the Free-Fare Transit Experiments," A. H. Studenmund in Transportation Research Record #719, Transit Development (Washington, DC: Transportation Research Board) 1979.

Perhaps the best way to evaluate the potential for subsidizing low income MBTA riders is to estimate the number of program participants based on the number of residents eligible for the Food Stamps program or Aid to Families with Dependent Children (AFDC).* In the Boston area, the Food Stamps program has roughly one-third more participants than AFDC does. In order to provide an estimate of the maximum revenue loss and ridership gain associated with a subsidy program, eligibility for food stamps will be considered as the basis for transit subsidies as well. There are approximately 92,000 households in the Boston area that participate in the Food Stamp program. They constitute approximately 9.5 percent of the region's households. The 1978 MBTA ridership survey indicates that the percentage of riders from low income groups is significantly higher than the percentage they represent in the general population. According to the survey, 23.8 percent of the MBTA passengers had household incomes under $8,000 in 1978, whereas 12.8 percent of all Boston SMSA residents are in this income group. Thus, it appears that MBTA ridership from this group is 86 percent larger than might have been predicted based on general population statistics. If it is assumed that this relationship holds true for potential MBTA riders from families in the Food Stamp program, then the reduced fares would apply to 17.7 percent of all transit trips. Assuming a fare elasticity for low income riders of .19 (Ecosometrics, 1980) and a mode-split pattern similar to that of all transit riders in general, half-price fares for members of low income households would generate approximately 1.3 million trips per year with a total annual revenue loss of about $4.1 million. Revenue losses and ridership gains would be smaller if eligibility for the reduced fare were limited to AFDC recipients rather than Food Stamp program participants or if the reduced fare were something larger than half the full adult fare. Revenue losses are probably overstated in this example because low income children and elderly are already paying reduced fares. A description of a program where the state could subsidize these riders is provided as a potential mitigating measure.

A brief mention should also be made of reduced fare programs aimed at riders with very elastic responses to fare changes. An example of this type of behavior is travel that is not CBD-oriented. Travelers bound for the downtown are generally half as responsive to change in fares as others are. Theoretically, routes with neither origin nor destination in the downtown area could be subject to lower fares. This policy would help to minimize the significant ridership losses associated with fare increases. There is not enough data available to quantify the impact of such a program on MBTA ridership or revenue.

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*A review is presented in an EOTC memorandum, "Estimate of Cost of Fare Subsidies for Low Income MBTA Riders," July 29, 1980.

5.3.3 Reduced Rates for Transfers

Programs that offer reduced rate transfers between vehicles on a single transit system can be designed in a number of ways. Transfer fees may range anywhere from full fare to free. Reduced rates may be offered on transfers from bus-to-bus, rail-to-bus, or rail-to-rail. Some transit facilities discount all transfers between vehicles while others limit the special fares to a small market segment such as express bus-to-rail transfers.

Very few properties have full-fare transfers on buses. Transfer fees are fairly uniform nationally and generally fall between zero and 10 cents. A small fee is often employed in order to prevent abuse of the system; riders are less likely to collect transfers with the intent of giving them away or selling them if some fee is charged. The distribution and collection of slips may slow the entrance or exit of passengers and thus cause some system delays.

Transfer fees on other fixed rail systems are less uniform. Fees are commonly set at either full fare or half fare or they are free. The design of many rail facilities limits the feasibility of less than full fare transfers. Vehicle delays and increases in dwell times are generally less of a problem on rail systems than on buses.

Several mechanisms are available for actually implementing a reduced-fare transfer system. Slips from bus drivers or booth men, passes, machine slips, and limited access transfer areas are all possibilities. Bus transfers usually use driver-distributed slips, and therefore, these programs frequently have lower costs than similar rail programs.

The most marked effect of a reduced-rate transfer policy is the loss of revenue involved. Associated with this loss, however, is a significant increase in transit ridership due to the reduced fares. In most cases, those reduced rates are being offered to riders whose previous linked trips were among the most expensive per mile in the system. For this reason, the reduction in system revenue can often be justified as an equity measure.

There are a number of problems associated with reduced-rate transfer policies that are unrelated to revenue. One is the problem of checking the validity of the transfer slips. Either extra gatemen must be hired or bus drivers would need to increase their dwell time at some stops to examine the slips. Another problem is the cost of the slips themselves; a 1976 study* placed their value at $225,000 per year in Boston. The machines that dispense the transfer slips also represent a significant capital outlay. Passenger wait times can be increased by lines at dispensing machines and collection points. In other words, there are many methods by which reduced-rate transfer policies may be implemented; none of them are flawless.

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*Massachusetts Bay Transportation Authority, Report of the Fare Review Task Force, Phase III, Boston, Massachusetts, November, 1976.

In order to evaluate the ridership and revenue impacts of a reduced-fare transfer policy in Boston, some estimate of the number of transit riders who make transfers on the MBTA must be calculated. The 1978 MBTA Systemwide Survey indicated that approximately 40 percent of all trips require a transfer between modes and about 5 percent require a transfer from one bus to another. A large number of reduced-fare transfer configurations are possible. The repercussions of a few will be looked at here.

One popular design for reduced-rate transfers is that of offering a free transfer from subways to buses. The typical adult paying full fare now pays $2.50 for this trip, but would pay only $2.00 under this system. If it is assumed that half-fare riders are also offered the free bus trip and passes are discounted accordingly, combination trips might be expected to increase by about 8,000 per day. This translates into a net gain of over 2 million riders each year with an annual revenue loss of about $8 million. If a small fee were charged for each transfer slip, the revenue loss and ridership gain would, of course, be slightly smaller.

Another option that merits consideration is that of free transfers between buses only. This policy would prevent riders from being penalized simply because their trips did not coincide with designed bus routes. Approximately 24,000 people make transfers from one bus to another on an average weekday, based on the updated results of the 1978 MBTA Systemwide Survey. Free transfers would, therefore, increase the annual number of bus-to-bus transfers from about 6.9 million to about 7.9 million. At the same time, revenue from these passengers would decrease from nearly $6.9 million to close to $4 million.

The number of possible reduced-fare transfer plans is almost limitless, yet any plan by necessity implies a gain in ridership as well as a loss in revenue. The different fare configurations can alter the magnitude of these changes and can target certain groups within the transit riding population as beneficiaries.

5.3.4 Lower Fares for Downtown Travel

The reduction of transit fares in downtown areas is an increasingl popular alternative to flat fare systems. Many cities that initially launched such programs as experiments have adopted them as part of their permanent fare structure. Revitalization of the downtown is frequently as important a goal for these programs as increasing ridership on the transit system.

Basic to the implementation of free and reduced-fare downtown distribution systems is the definition of a "downtown zone." Many cities focus on tourist areas, some on the retail district, and others cover most of the central business district. Reduced fares may be implemented on existing routes that travel to or through the downtown, or special downtown loop services may be established. Low fares on downtown loops may reflect a low cost due to limited route length and high density of use and the lower incremental value of such trips to the individual user. In some areas, downtown merchants contribute to the financing of these systems.

The objectives of these reduced fare programs generally include revitalization of the downtown area, including an increase in retail activity, reduced traffic congestion, decreased pollution, increased transit patronage, and an improvement in the image of public transportation. The single largest negative impact of such programs is the loss of revenue from those riders already making trips within the CBD. Another problem is that the service may slow systemwide bus operations slightly if increased ridership lengthens dwell times significantly. Systems that have instituted such programs seem generally satisfied, however.

Two cities that offer fare-free downtown distribution are Albany and Seattle. In November 1978, the Capital District Transportation Authority (CDTA) eliminated transit fares in a two-thirds square mile zone in downtown Albany. The free-fare program was in effect from 9 AM to 3 PM weekdays and from 9 AM to 6 PM on Saturdays. Downtown weekday ridership tripled; Saturday ridership in the CBD increased five-fold. Downtown retail sales also reversed a long-term decline and increased almost 10 percent. The two-year demonstration program has been continued indefinitely, although the hours have been trimmed slightly. A merchant's association is jointly financing continued service with CDTA and the City of Albany.

In 1973 in Seattle, METRO Transit began offering free fares in a one-half square mile zone downtown during all hours and all days of the week. The original zone covered primarily tourist retail areas, but has been expanded to include urban renewal and some residential uses. Intra-CBD ridership has tripled since the program began. METRO Transit discovered several interesting facts about their free downtown distribution system. First, most of those who made their trip prior to free fares walked (45 percent) or rode the bus (41 percent). The impact on traffic and parking has, therefore, been negligible. Second, free-fare passengers generally have higher incomes than other transit users.

Third, most of the new trips were between 11 AM and 2 PM and involved some kind of purchase. Seattle's free-fare program has also been continued indefinitely.

The applicability of these reduced-fare downtown distributor systems to the situation in Boston is limited. Most of the transit service offered within the downtown is subway service. It would be very difficult to implement a system whereby transit riders could ride between downtown stations at a reduced price. It would probably be necessary to give a timed and dated receipt to those who board downtown; the receipt could then be exchanged for cash if the rider also exited downtown. This type of system is used for local trips on the Quincy Branch of the Red Line. Abuse of either system would be impossible to prevent. There would undoubtedly be a certain number of people exchanging receipts or giving them away. The costs involved, including increased manpower or machinery to give out receipts, gatemen to check them and hand out refunds upon exit, and the costs of the receipts themselves.

Another possible option might be the introduction of reduced-fare buses just for downtown circulation. The MBTA offered a bus from South Station to Downtown Crossing during the Christmas holiday season in 1981 for 25 cents. The adoption of this type of program on a large scale would be prohibitively expensive.

The revenue loss and ridership gain resulting from a reduced-fare downtown distribution system would be directly related to the degree of subsidy applied to the downtown trips. No good data is available on the number of intra-CBD trips currently being made in downtown Boston.

5.3.5 Comparison of Alternatives

The projected impacts of the various fare structure alternatives are summarized in Table 5-2. Factors that cannot be quantified, such as "ease of implementation," were rated on an ordinal scale. Comparison of the different programs shows that for a given change in ridership, a number of different revenue and VMT changes may be expected depending on the specific group within the population that is targeted by that program. For example, losing a certain number of elderly riders would have a smaller impact on revenue than losing the same number of full-fare riders. This is illustrated in the peak period surcharge alternative in which about $7 million in additional revenue is expected while only 2 million annual riders are lost. The relationship between VMT and ridership varies in a similar way; the increase in VMT for a given loss in commuters is nearly twice as large as it would be for the same number of students. While the actual values listed in this table may not be definitive, they offer a good basis for comparing the results of the fare structure programs.

5.4 ALTERNATIVE FARE PAYMENT METHODS

In addition to the self-service alternative described in detail previously in Section 5.3, several other alternative payment systems have been considered in this study. Fare collection systems currently in use in the United States range from completely manual operations to fully-automated systems. The type of fare collection system is dependent, in part, upon the type of fare structure, such as flat rates, zonal fares, or mileage-based fares. The type of fare structure, in turn, dictates what type of collection system is needed.

Currently, fares are paid on the MBTA by using one of four methods: cash, token, prepaid pass, or ticket. Tickets are used only on a few express buses; cash, tokens, or passes are accepted on surface vehicles. Access to rapid transit lines requires either a token or a valid prepaid pass. Prepaid passes are purchased monthly by riders and permit unlimited travel on certain facilities throughout the month. Passes good on single

EFFECTS OF ALTERNATE FARE STRUCTURES

SUMMARY TABLE

Fare Structure Alternative	Change In Annual Ridership (millions)	Change In Annual Revenue (millions)	Change In VMT (millions)	Hydro-Carbon Emissions (tons/year)	Cost of Implementation	Ease Of Implementation	Political Feasibility
Low fares downtown	+	-	Negligible	Negligible	-	-	+
Self-Service	+	?	-	-	-	-	-
Free off-peak elderly	+6.7	-1.3	-7.2	-15.1	?	+	+
Full-price students	-2.5	+4.0	+3.4	+ 7.1	+	+	-
Half-fare for low-income	+1.3	-4.1	-3.5	- 7.4	-	-	?
Peak period surcharge	-<2	+6.5 to 7.8	+6.2	+13.0	+	+	+
Free rail-to-bus transfers	+2.0	-8.0	-6.2	-13.0	-	+	+
Free bus-to-bus transfers	+1.0	-2.9	-3.1	- 6.5	+	+	+

Source: C.T.P.S.

EFFECTS OF ALTERNATE FARE STRUCTURES

TABLE
5-2

vehicles are based on the cost of 18 roundtrips; passes good on two types of vehicles (e.g., bus and rapid transit) are based on the cost of 16 roundtrips made using both types each way.

Although passes technically are valid for only one rider's use, there is no control over the "lending" of one's pass to other riders. Recently, the MBTA has changed its passes so they can be read electronically at turnstiles in rapid transit stations.

A fully automated, electronic fare collection system would allow for a more diversified fare structure. Manual fare collection systems require that fares be either flat rates for all riders, or vary by only a few zonal boundaries. With a fully-automated fare system, fares could be designed on more specific mileage-based formulas. These would more accurately reflect the cost associated with the distance traveled as well as the cost associated with a particular mode.

5.4.1 Electronic Fare Collection

Electronic fare systems are in operation in Washington, D.C. (WMATA) and San Francisco, CA (BART). The nature of the systems permits fares to be set by time-of-day and distance between stations. Tickets purchased at vending machines in the rapid transit stations or at banks are required to enter and exit the system. In this manner, the fare is adjusted between the entry station, which, along with the time, is encoded on the ticket, and the exit station. These systems, however, have experienced several problems associated with equipment failure. To date, these systems have been implemented on transit lines having off-vehicle payment. Electronic fare collection systems would be difficult to institute on buses, where zonal systems are also the most difficult to initiate.

A fully automated system of the type described above would be expensive to implement on the MBTA. Ticket sales equipment and adjustments to turnstiles would be necessary. Instead, the MBTA is investigating enhancements to their prepaid pass electronic card system. This system is described in Section 7.1.2 in connection with productivity measurement programs.

5.4.2 Bulk Sale of Tokens

Another alternative which may be beneficial to riders and to the MBTA is bulk sale of tokens. MOlst prepayment plans including bulk sale of tokens offer a discount to buyers. According to a 1976 UMTA report, this is done for a variety of reasons including:

(1) Social policy, which dictates that some riders deserve lower fares,

(2) a general belief that discounts are appropriate for bulk sales because of the lower handling costs,

(3) a marketing judgment that the discount for and convenience of prepayment will encourage reluctant riders and additional trips by current users.

According to this report, the marketing reason was the most common reason among transit authorities surveyed for implementing bulk sale of tokens/tickets with a discount. There were savings reported by 20 of 32 authorities due to reduced coin handling and a small benefit to the authority's cash flow in cases where riders purchased tokens in bulk. An additional smaller amount of cash value was received by transit authorities through the loss, by riders, of tokens/tickets resulting in rides paid for but never taken.

Several transit authorities have recorded increases in ridership and efficiency where bulk token sales or similar programs have been implemented. In Stockholm, winter-season ticket holders (a bulk-type pass ticket) climbed in one year from 135,000 to 400,000. Season-tickets riders climbed from one-third of all riders to 70 percent in a year. Of course, there was a decrease in single-fare riders, but overall, ridership climbed 5 percent.*

In conclusion, bulk sale of tokens with discounts would appear to be convenient and advantageous for both riders and transit authorities. Riders pay less to travel and wait in line less; stations are less congested at token booths, and transit authorities can expect to maintain or increase revenue with marginal additional ridership.**

5.4.3 Self-Service Fare Collection

The basis for self-service fare collection is that each passenger is generally responsible for determining and paying his own fare. Riders are then subject to a fine or other sanction if proof of payment cannot be produced for an inspector. Self-service systems are fairly common in European cities but have been implemented only on a very limited basis in the United States.

A two-step process consisting of ticket purchase and later ticket verification is usually employed in self-service systems. The two steps are separated to permit multiple ticket purchases. Tickets may be sold by machine (accompanied by high capital cost, vandalism, and little revenue security) or by ticket agents or concessionaires (with high labor costs). Most systems sell tickets that act as receipts when verified at time of use. Inspectors are assigned to vehicles with the aim of checking each regular passenger on a certain percentage of bus trips (e.g., every twenty trips). Fines are then designed to recapture all lost fares assuming that the delinquent rider has not paid the fare since the last inspection; if inspections occurred every twenty trips, the fine would be twenty times the fare.

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*Michael Kemp, Reduced Fare and Fare-Free in Urban Transit Services, Urban Institute Paper, July 1974, p. 33.

**Transit Fare Prepayment, UMTA, DOT, August 1976, p. 65.

Several possibilities exist for ticketing and ticket validation procedures. The three most frequently adopted configurations are:

- issue and validate at stops only
- issue at stops, validate on vehicle
- validate on vehicle, no ticket issued

All of these options offer barrier-free access to vehicles leading to decreased dwell time at stations and stops. Turnstiles can be abandoned at subway stations (or used for counting riders only) and "all doors" access can be provided on buses and streetcars.

The potential increases in productivity resulting from these changes are one of the major benefits of self-service systems. Most European properties reported approximately a 10 percent service productivity improvement based on self service.* A second major benefit seen by the European operators was the increased feasibility of diversified fare structures aimed at various market segments and geographic areas. When the responsibility for computing and verifying fares was removed from vehicle drivers, more innovative and complicated fare structures became possible. Other benefits realized by self-service systems include lower fare collection costs in subways where extensive fare collection equipment is no longer needed, and improved passenger statistics provided by ticket verification machines recording time and location of trips.

It appears that European properties have had a generally positive experience with self service fare collection. The feasibility of implementing such systems in the United States, and perhaps particularly in Boston, poses unique problems. Problems surrounding implementation in Boston can be divided into two groups, those dealing with purchasing and maintaining automated equipment and those involving enforcement of fare and fine payment.

The high capital costs of automated ticket purchasing and ticket verification present a large, but probably surmountable, obstacle. Judging from other systems, the pressing problem would be the maintenance and protection of the machines. Ticket validation machines are especially sensitive, and machine malfunctions can be caused by routine occurrences like wet or damp tickets and vehicle vibration, as well as by intentional vandalism.

Enforcement of fare payment is also anticipated to be a problem. The riding public would have to take the ticket inspectors seriously. The transit system in Geneva was forced to double its fines in order to pay the city police to administer the fine collection system. Such a partnership would probably be necessary in Boston as well. Writing tickets to individuals requires that some form of identification is available. Furthermore, in a city where in 1980 as few as 20 percent of all fines for parking violations were paid, the transit system may have difficulty collecting enough revenue to support the administration of a self-service system.

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*Self- Service Fare Collection, Volume 1, Review and Summary, Mitre Corporation for U.S. DOT, August, 1979.

Self-service fare collection is generally credited with increasing transit ridership through improved service performance. Decreased dwell times on surface vehicles shorten travel times and enhance the potential for decreased headways. Lowered costs due to improved productivity can be passed along to the passenger in the form of decreased fares or slower increases in fares. As ridership increases, revenue from transportation increases as well. The enormous cost of enforcing fare payments in Boston may overshadow other savings, however, leaving the system no better off than it was previously.

These facts highlight the reasons why a system that is feasible in many European and Canadian cities may not work here. The single, well-publicized instance of a successful self-service system in the United States is in San Diego. The San Diego trolley, however, is a special case experience that may not be transferable to Boston for a number of reasons. The Metropolitan Transit Development Board (MTDB) was created in 1975 expressly to develop and maintain the trolley service, independent of the five other operators in the region carrying 28 million passengers annually. As it was, a new system, the implementation of self-service fares on the MTDB, was fairly straightforward and was simple to monitor. Furthermore, the decision to implement such a system in San Diego was made before the system was built and, therefore, reduced construction costs considerably. MTDB officials estimate that losses due to increased fare evasion will be more than offset by savings in construction costs. The eleven stations on the line do not need to be enclosed because they are not used to prevent unauthorized access to the trolley. The promise of reduced construction costs obviously holds little interest for Boston whose basic system has long since been constructed. It appears, therefore, that although self-service fare collection systems have been successful abroad and to a limited extent in the United States, their feasibility in Boston is of questionable benefit.

5.4.4 Impacts of Alternative Fare Collection Systems

The impacts of alternative fare collection systems have not been quantified. It is assumed that improved collection techniques might reduce dwell time, thereby reducing the total trip time. The impact on ridership, VMT, and the environment from this alone is assumed to be negligible. However, if these methods significantly change the level of service provided or offer savings either directly or secondarily through systemwide cost reduction, impacts would be measurable. Furthermore, the benefits of a system such as a fully automated system could become significant because of the ability to set fares more equitably.

5.5 LEGISLATIVE PROGRAMS

Some measures which would lessen the impact due to fare increases and service cuts of the sort implemented in 1981 are outside the direct control of the MBTA. Since both fare and service changes are required because of financial problems, additional funding sources in conjunction with improved operations are the key to the solution. Changes to the funding structure could not be implemented solely by the MBTA but would require state legislative action. Potential programs include state or local takeover of MBTA-sponsored subsidy programs, alternative funding through sales or gasoline taxes, or fare levels tied to inflation. These programs have been outlined below.

5.5.1 Subsidy Programs

As explained in Section 6, the MBTA currently subsidizes transportation for several groups of people: elderly, handicapped, students. The MBTA has requested that, as part of this study, the impacts of these subsidies on revenue be estimated and alternative mechanisms for subsidizing be addressed.

The cost of subsidizing the elderly has been estimated to be $12.0 million per year based on the current fare structure. The MBTA has suggested that the Human Services Division of the state or the Department of Elder Affairs pick up the cost of subsidizing travel by the elderly. The state could buy either tokens or passes at full face value and in turn either sell them at reduced rates to qualifying individuals or give them away. In this manner, the MBTA would receive the full value for the service provided. This type of program could also permit low-income individuals to be subsidized in a similar manner. If the Human Services Division set eligibility requirements for low-income riders, the tokens or passes could be distributed at reduced rates to qualifying individuals. A mechanism to prevent abuse of the reduced rates would have to be set up by the administering agency.

Similarly, school departments are subsidized by the MBTA for transporting students to school. The loss in revenue for school trips totals $2.8 million per year. If the MBTA sold student badges to school departments for an amount equal to the fares paid by students over the course of a year (i.e., half fare X the number of school days X two trips per day), the MBTA would recoup the money spent on subsidizing student trips.

5.5.2 Alternative Funding Sources

The present funding sources of the MBTA, which have already been identified in Section 2.7, include the federal, state, and local governments and the MBTA passengers. As the federal government operating subsidy is being phased out and local government finances are being restricted by Proposition 2½, alternative sources of funding are being sought. The state's share comes primarily from the general tax fund and gasoline taxes; the local share comes from the property taxes. The equity associated with these alternative tax sources has been addressed in Section 6.0

Additional possible sources of revenue include the following taxes: sales, gasoline, payroll, employer, parking, auto excise, and other excise taxes. Evaluations of these methods have been conducted in various studies with regard to criteria such as: yield potential, economic benefits, equity, political acceptability, and administrative difficulty. An investigation of taxes shows that some are strong in some areas, but weak in others. One with a high potential yield may be politically unacceptable; one which features an equitable share of burden for all economic groups may be impossible to administer, etc. A short discussion of several alternative revenue sources follows:

A. Sales Tax

The sales tax is the most popular tax for transit nationally, with 9 of the country's 26 largest metropolitan areas using it to complement their federal subsidies. It has a high potential yield and will keep pace with inflation. A one percent increase in the tax would bring in $75 million annually to the MBTA district.* Opinions differ as to whether sales taxes are regressive. Palmere** says they're fair, but others including UMTA say "sales and excise taxes are much more regressive than any other major family of taxes." Yet public opinion polls, according to UMTA, show that retail sales taxes are popular as means of additional revenue.***

In Atlanta, a one percent sales tax and use tax was levied in two counties to allow fare reduction. Sales tax and fare revenue were applied to meet development and operating costs. The immediate result was a 30 percent increase in ridership. A survey in November of 1972, 10 months after the decrease in fares, showed 91 percent of the increase was due to new riders and 41.8 percent of the new riders previously made the same trip by automobile.**** The Atlanta study also reported the sales tax was regressive, but pointed out that consideration had not yet been given to the "compensating effect" of the low fare.

The problem with a sales tax, in addition to its alleged regressivity is that it may decrease sales in a region and cause shoppers to go beyond borders to bury certain things. The sales tax, also, is not directly tied to the transit problem as is, say, a tax on parking or gasoline.

B. Gas Tax and Auto Use Charges

Gas tax and auto use charges were a prominent proposal of the Governor's Task Force on the MBTA. It also has the support of the Carmen's Union. It would conceivably cause a reduction in auto use, and improve air quality and reduce energy consumption. The poor would pay less and the middle class more, but people could control their costs by driving less or carpooling. As a revenue source, it would be a reliable one with as much as $10 million annually in the district. Five metropolitan transit systems currently gas taxes.

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*Anthony J. Palmere, Alternatives for Financing the MBTA, (unpublished thesis), Kennedy School of Government, Harvard University, 1981.

**UMTA, Department of Transporatation, Financing Transit, Alternatives for Local Government, July, 1979.

***John W. Bates, "Using Sales Tax to Support Low Fare Pricing of Transit Services in Atlanta" in Urban Transportation

****William C. Nevel, "Case Studies on Increasing Transit Revenues: Northeastern Illinois," Urban Transportation Economics.

An UMTA report, however, takes the slightly different view that only a large increase in the gas tax would have an effect on travel and travel patterns because of the low elasticity of demand for fuel and travel. Automobiles, the report claims, are and will still be used for trips for which there is no transit alternative.

Parking taxes are a form of auto use charge that according to one study would yield a "modest, but significant amount of revenue". There has been resistance, however, on the part of parking lot operators, particularly in San Francisco, to these programs. The objections are principally that these taxes:

(1) Discriminate against drivers who are obliged to use commercial parking facilities.

(2) Place a financial burden on the parking industry.

(3) Had little effect (in the San Francisco case) on traffic coming into the city because only about 20 percent of the incoming vehicles used commercial parking facilities.

There is little information on the effects of parking taxes on different income groups.

Bridge and tunnel tolls would seem to be directly related to reducing traffic congestion but only 3 cities--New York, Philadelphia, and San Francisco--use them to partly finance transit. There are implementation problems including legal obstacles related to how the revenue from tolls can be spent. Generally, it is directed only to the maintenance and reduction of capital debt of the tolled facility.

C. Payroll Taxes

Payroll taxes are imposed on employees or the employer. It may be assumed that they are passed on to employees. If paid by the employer, the tax could be deducted as a business expense. Generally, under these proposals, small firms are not taxed, but this means that doctors, lawyers, and other self-employed people may not be taxed at all. Small companies and those located outside the district would gain, some would say, an unfair advantage. Other companies making a location decision may elect to locate outside the district. The greatest objection to these taxes is that they are already used heavily for retirement, social security, and workmen's compensation.

The potential yield is high from payroll taxes for a small percentage tax. As with the gas and sales tax, it is tied to inflation. The estimated revenue gain for the district is $72 million annually with only a one half percent increase.

Other revenue sources considered by transit authorities have included: joint development of air rights over public property or leasing and/or sale of supplemental property; taxes on so-called "harmful" products such as liquor or tobacco (Massachusetts used to collect 2 cents per cigarette pack for transit funding); increases in the personal income tax (this has been considered by some transit agencies but is generally considered politically unacceptable). Finally, the City of Chicago considered a lottery (it was not legal at the time) to raise $60 million/year with one-half going to mass transit.

5.5.3 Cost-of-Living Indexing

One proposal being set forth by the MBTA would provide the MBTA with periodic fare hikes based on inflation. As the costs to the MBTA of providing service increase due to factors outside the control of the "T", such as increased fuel costs, the fares would be increased to compensate for these costs. A system of this type could be tied to the Consumer Price Index (CPI), the Producer Price Index (PPI), or, since the MBTA is an energy-intensive operation, a motor fuel price index. Adjustments could be made to the fares either annually or, more likely, biennially. Further refinement would be necesary to ensure a rounded fare level (e.g., to the closest 5 cents).

Fare changes tied to these indices would be most significant during times of inflation. For example, if inflation were 10 percent over the time period measured, fares would increase by 10 percent. Tables presented in Section 2 have pointed to the disparity between real costr and real fares over time; fares have not kept up with inflation. As an example of the cost of living indexing proposal, it was assumed that inflation over the next two years is 10 percent per year. This translates into an increase in fares of 21 percent to roughly 60 cents on the bus and 90 cents on rapid transit. If fares were adjusted annually, the fares after one year would be 55 cents and 85 cents.

It is expected that small adjustments to fares each year would not have as dramatic an impact on ridership, especially if they are tied to the cost of living index. Regardless, some riders would divert to other modes.

5.5.4 Recommendations of Other Studies

The UMTA report Financing Transit does not recommend a clear-cut alternative revenue-source because of the various kinds of inequities each tax incurs. What they do recommend is "greater financial and operating efficiency" and responsible financial management.

Accounting and management data are, or should be, brought together in the operating budget which, as the operating plan, should be a principal tool for decision-making by transit agency managers and boards of directors. Moreover, now that a large and growing proportion of transit operating costs are paid for by tax revenues, rather than fares, local and state elected officials and legislators will increasingly demand to know what they are getting for their subsidy funds, in terms of concrete services. A financial plan, therefore, must require not only the analyses to provide such information, but also that the information be intelligible and persuasive, if transit is to hold its own in competition with other public services.

The system proposed for Chicago's Regional Transit Authority included revenue from the sales tax, a $14 excise tax for vehicle registration, a 5 percent sales tax on motor fuel, and an all-day (commuter) parking tax. Thus, some areas are experimenting with combinations of taxes.

Anthony J. Palmere's Alternatives for Financing the MBTA makes recommendations for the short-run, while developing some long-range goals for the MBTA. In the short-run, Palmere suggests a gas tax combined with an increase in fares "to let people know that transit will only receive limited public financial support in the future." Under this proposal, gas prices and fares would rise together so that neither would have an unfair advantage. Palmere suggests a sales tax as a second alternative to assist local communities in coming up with their share of MBTA funding.

The long-range goals developed by Palmere echo the comments of the UMTA report--the MBTA must be run more efficiently. If possible, some system of incentives should be provided to increase efficiency. Palmere also recommends a user subsidy for low-income riders since the MBTA will be depending on operating revenues.

One point on which many of the studies could agree was raised by Ralph E. Rechel and others: ". . . a funding source is needed tha will expand with inflation. A perpetual problem exists if this basic need is inadequately addressed."

6.0 SOCIOECONOMIC IMPACTS

The purpose of this section is to identify and describe the impacts of recent fare increases and service cuts on various broad socioeconomic groups. First, the social benefit of public transportation is discussed in terms of both direct user and indirect non-user benefits. Next, a description of the impacts of fare increases and resultant reduction of trip-making is provided by user type and socioeconomic group, where possible. The losses in trips made by the elderly, the handicapped, youth, and low-income users are estimated. In particular, changes in the number of discretionary trips and shopping trips are noted.

Several categories of users have been identified as being more negatively affected by the fare increase. Some measures that may be taken to mitigate the impacts of the fare increases on these users have been outlined, and the MBTA's existing subsidy programs are described.

6.1 SOCIAL AND ECONOMIC VALUE OF PUBLIC TRANSPORTATION

A basic goal of public transportation is to provide mobility and equality of access to employment, health care, educational, cultural, and shopping opportunities. It strives to provide efficient transport of people in and through urban areas. Furthermore, public transportation enhances the broad goals of promoting social and economic equity for residents of urban areas, as well as increasing employment and employment opportunities, revitalizing the economic base of central cities, and improving the quality of life in an urban environment.

The socioeconomic value of public transportation can be discussed in terms of direct and indirect benefits to users and non-users and is realized at both the individual and community, as well as on a regionwide level. The social and economic impacts of public transportation can most easily be described in terms of captive and discretionary ridership.

Captive Ridership

Captive riders are generally from autoless households and are dependent upon public transportation for access to employment and essential services. Although the majority of Americans depend on the automobile as their primary mode of transportation, significant populations of the poor, the elderly, and the handicapped in urban areas cannot affort or are physically unable to operate an automobile. The majority of autoless households generally reside in urban core areas, tend to have lower incomes and are often elderly. It is for this segment of the metropolitan population that public transit is critical to the quality of life. These population groups constitute the majority of captive riders on transit systems.

Low-Income Riders -- Public transportation has particular value to the low-income captive rider. Public transit increases his job opportunities by providing transportation to employers. A 1978 Ridership Survey conducted by the MBTA revealed that the majority of transit trips made by the low-income captive rider were work trips. The direct benefit to the low-income captive rider and his employer is realized as an indirect benefit to society in the form of increased employment levels, greater economic productivity, and reduced dependence on public assistance.

Elderly and Handicapped Riders -- Elderly and handicapped residents of urban areas are often living on reduced or fixed incomes and unable to affort private transportation. The elderly and handicapped also have a greater incidence of physical disability which prevents them from operating an automobile, making them dependent on public transportation for access to employers and essential services. It, therefore, provides an essential social service to the elderly and handicapped. In terms of future transportation policy, it is important to note that persons over 65 years of age will represent an increasingly large percentage of the general population.

Discretionary Riders

Discretionary riders are defined as those persons who have access to an automobile and, therefore, have a choice whether to use public transportation. Public transit supplies benefits to these riders by providing them with an alternative mode of transportation for work and other trips. The 1978 MBTA Ridership Survey revealed that discretionary riders use the transit system primarily for commuting trips.

Reduced travel time and costs are major reasons for the diversion of discretionary riders to mass transit. The most significant time savings are realized on rail facilities having exclusive rights-of-way. Cost savings are realized through reduced automobile operation and maintenance expenses, eliminated parking fees, and reduced insurance premiums. Another benefit accrues from public transportation being a safer mode of travel than the automobile, which reduces the likelihood of personal injury. This is particularly the case during adverse weather conditions, when transit may provide not only a safer, but a more reliable form of transportation. Data indicates that ridership levels increase during inclement weather.

Non-User Benefits

Public transportation also provides indirect benefits to the automobile commuter, urban resident and retail and commercial establishments. As persons divert to transit, a reduction in automobile use occurs, which reduces congestion, potential accidents and fatalities, and improves travel times for other motorists. These impacts are most evident during peak travel periods. Although such benefits may not be obvious to the urban motorists, the positive impact of mass transit systems on the operation of roadway systems becomes readily apparent when the transit system shuts down. Indirect public health benefits also accrue from the reduced traffic congestion and improved traffic flow in the form of reduced auto emissions, a major source of urban air pollution.

As stated previously, public transit has a positive impact on employment to the extent it increases job opportunities for the captive rider and links labor with potential employers. Transit authorities also act as major employers, creating jobs for the development, construction and operation of the transit system. In 1980, the MBTA employed 6,748 persons, with a total annual payroll of $140.5 million.* Transit authorities also provide jobs for architectural, engineering and other consultants. Employment directly or indirectly attributable to public transportation stimulates the economy by increasing disposable personal income, leading to greater consumption of goods and services. Greater consumption of goods and services can in turn stimulate industries and create additional jobs.

Public transportation has the positive impact of increasing land values near access points to the system; attracting desirable residential, commercial and retail land uses; and increasing local tax bases. This dynamic is most readily apparent in new extensions such as the extension of the Red Line to the South Shore.

It also enhances business in downtown shopping centers by increasing their effective service area. Auto travel to urban shopping centers is typically associated with traffic congestion and high parking fees, especially when compared with the suburban shopping mall. The success of downtown shopping areas served by public transit is well documented in Boston and other U.S. cities Attendance at sporting and cultural events, and other downtown recreational activities is also increased.

In summary, public transportation provides both user benefits in the form of increased accessibility to employment, shopping, and cultural opportunities, and non-user benefits such as decreased traffic congestion, increased land values, and increased labor markets.

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*MBTA 1980 Annual Report.

6.2 CHANGES IN RIDERSHIP LEVELS FOR SOCIOECONOMIC CATEGORIES OF USERS

Several groups of users who appear to be more sensitive to a fare increase have been identified in Section 6.1. These include low-income persons, students, elderly, youths, and handicapped persons. In addition, persons making discretionary trips (shoppers, tourists) and non-captive commuters (those having an automobile available) are more likely to change their trip-making behavior due to a fare increase or service change. An attempt has been made to identify the number of trips made by each of these groups of users before the recent fare increases and determine the magnitude of the change in trips following the changes in fares and service levels.

The base information was obtained from the 1978 Systemwide MBTA Survey, adjusted to reflect 1979 ridership levels. The 1981 level was derived either from the fare mix sampling program of November 1981, or through the application of disaggregate elasticities to the 1979 levels. The results of this analysis are presented below by type of user.

It should be noted that, although the handicapped have been identified as a group that benefits from public transportation and in some cases is dependent upon it, the impacts on this group of users is not addressed separately. Instead, those handicapped persons using the MBTA's regularly scheduled service have been grouped with the elderly. This was done for a few basic reasons. First, the 1978 Systemwide Survey, which serves as a base for these socioeconomic groupings, did not have a statistically significant number of responses from handicapped riders. Detailed breakdown of their trip-making behavior was not, therefore, possible. Second, the MBTA provides a demand-responsive system for handicapped persons called The Ride, which was not affected by these fare increases. Third, the fare changes seen by the handicapped were the same as those facing the elderly and, therefore, permitted combining the two groups. In addition, the 1981 ridership sampling program grouped the two categories of users in their breakdown of fare payment.

6.2.1 Income

Low-income persons are generally more dependent upon public transportation for their travel needs than are persons in the middle-income or upper-income groups. According to the 1977-1978 National Personal Transportation Study (NPTS) conducted by the Census Bureau for FHWA, approximately one-third of the bus or streetcar users in cities with populations between 500,000 and one million people had low incomes (less than $6,000/household). In contrast, only 11 percent of the automobile drivers were in this income group. In general, low-income groups make up a larger portion of the streetcar or bus riders (28.3 percent) in all metropolitan areas than they do of the rapid rail (16.2 percent) or commuter rail riders (9.3 percent).*

The 1978 MBTA Systemwide Survey provided information on the household income of MBTA riders. Overall, 23 percent of the total riders had household incomes less than $8,000 in 1978. The survey might have underestimated the proportion of low-income riders because the sensitivity of this type of question results in many "no answers". For this analysis, the 1978 income levels have been increased to 1979 and 1981 dollars by using the change in personal income for the state over this time period.**

The number of trips made by low-income persons on an average weekday are as follows:

	1979		1981		Change	
	No.	% of Mode	No.	% of Mode	No.	% of Mode
rapid transit only	37,100	(20.3%)	27,600	(20.5%)	- 9,500	(-25.6%)
combination rapid transit and surface	54,200	(21.5%)	43,600	(22.4%)	-10,600	(-19.6%)
surface only	56,900	(29.2%)	49,300	(27.7%)	- 7,600	(-13.4%)
TOTAL	148,200	(22.8%)	120,500	(23.7%)	-27,700	(-16.1%)

Both the fewest number of trips and the smallest proportion of trips made by low-income riders are on the rapid transit system. As expected, the greatest proportion of low income riders made bus trips.

The loss in trips was estimated by adjusting the modal elasticities by a disaggregate fare adjustment factor of 0.72** and applying it to the change in average fare by mode. The factor is less than 1.0, indicating that the responsiveness of low-income riders to changes in fares is generally lower than that of the entire population. Low-income riders generally have fewer alternatives to transit, owning fewer automobiles per household and having a lower likelihood of an auto available for a particular trip.*** Although fewer low-income persons are riding the MBTA now than they were in 1979, a greater proportion of the system's riders are from low-income households. In addition, a greater proportion of their total household income must be devoted to riding the MBTA. The issue of fare burden per household is addressed in a subsequent Section 6.4 of this report.

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*The numbers referred to the NPTS were reported in "Equity in Transit Finance," John Pucher, Journal of the American Planning Association, Volume 47, Number 4, October 1981.

**Ecosometrics.

6.2.2 Age

The age of individual riders is also of interest in determining the response to changes in fares. Two age groups are of particular importance in an analysis of the socioeconomic impacts of a fare increase--the young and the elderly. The effects of the fare increases over the last two years on each of these two age groups are described below.

The Young

The fares paid by this group of riders depend on age and trip purpose. Children under five years of age ride free at all times; those between five and eleven years pay half fare at all times. No identification card is provided to prove one's age, and so it is up to the discretion of the bus driver or token collector to determine the eligibility of a particular rider. In addition, children between 12 and 18 years making a school trip are permitted to pay half fare provided they show an eligibility badge. The badges are distributed through the local public and private school departments at no charge. Prior to July 1980, students were allowed free transfers.

Since 1979, trips made by children (5 to 11) and students dropped by approximately 28 percent. In all, 17,000 fewer MBTA trips were made by this group on an average weekday in 1981 as compared with 1979. It is important to determine which types of trips are no longer made and which ones are now made using another mode. It is a fair assumption that school trips are still made--students either walk, bicycle, or are driven go school by their parents. It should be noted that some school departments (e.g., Boston) are now subsidizing students who ride the MBTA to school by purchasing tokens or passes from the MBTA and providing them to qualifying students. Approximately three-quarters of the trips made by students and children appear to be school trips; one-fourth are, therefore, non-school trips.

In 1979, non-school related youth trips amounted to 15,000 trips per average weekday. In 1981, it is estimated that the number of trips of that type has dropped to 10,600 trips per day. The largest decline was estimated to be from rapid transit. It is

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***1978 Systemwide Survey data.

impossible to ascertain whether these trips are no longer made or are diverted to some other mode, e.g., walking, bicycling, or being driven. A mix of these possibilities is most likely.

Whereas in 1979, trips made by students and children constituted almost 10 percent of total system trips, in 1981, they comprised slightly less than 9 percent. The proportion of non-school related trips made by youths had dropped from 2.4 percent of total trips to 2.1 percent in 1981.

	1979* (No. Trips/ Avg. Weekday)	1981** (No. Trips/ Avg. Weekday)
Total Students and Children (5+) Trips		
rapid transit only	10,400	6,600
combination	29,000	18,800
surface only	21,900	19,000
TOTAL	61,300	44,400
Youth--Non-School Related Trips		
rapid transit only	6,500	4,100
combination	4,400	2,900
surface only	4,100	3,600
TOTAL	15,000	10,600

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*From 1978 MBTA Systemwide Survey.

**Derived from elasticities for non-school related trips; observed in November 1981 sampling program for total student/youth trips.

Elderly

As described in the introduction to this section, the provision of public transportation to the elderly produces significant user benefits as well as substantial indirect benefits to society. Due to the sensitivity of this group of riders to higher fares, the MBTA provides free access for the elderly to the entire system between 9:30 AM and 4:00 PM, Monday through Friday. Prior to August 1981, the elderly paid half the full adult cash fare based on fare levels charged prior to the 1980 fare increase. After August 1981, the fare structure required that the elderly pay half the current full adult cash fare except during the free-fare time period. For those riders who do not take advantage of the free fare time period, fares increased by between roughly 100 and 200 percent, depending upon the mode used. A similar fare structure is provided to handicapped riders; this discussion, therefore, includes both groups of riders.

Since the institution of free fares, elderly and handicapped ridership increased by approximately 13,000 riders per average weekday. Approximately 20,000 additional senior citizen identification cards were distributed by the MBTA in the last half of 1981 after the free fare was implemented. This group comprises over 12 percent of current average weekday ridership. This compares with almost 8 percent in 1979. Some ridership figures for the elderly and handicapped are presented below.

It was assumed that no work trips were lost from this category because of the relatively small absolute increase in fares seen by this group for a work trip. In order to avoid payment of the increased fares, it is expected that the elderly would switch the time of their trip for most discretionary trips rather than not ride the MBTA. As can be seen from the data below, it is expected that an increase of 35 percent of non-work trips has resulted since the fare change in 1981.

Total Elderly and Handicapped Trips

	1979*	1981**
	(No. Trips/ Avg. Weekday)	(No. Trips/ Avg. Weekday)
rapid transit only	14,300	16,900
combination	23,400	27,400
surface only	11,300	18,000
TOTAL - half fare	49,000	22,000
- free	--	40,300

Elderly and Handicapped Non-Work Related Trips

	1979*	1981**
rapid transit only	9,900	12,500
combination	18,500	22,500
surface only	9,300	16,000
TOTAL	37,700	51,000

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*Derived from 1978 Systemwide Survey.

**Derived from 1981 Sampling Program and 1978 Survey distribution of trip purposes.

6.2.3 Trip Purpose

Trip purpose has also been used to group responses to fare and service changes. Two groupings are of particular importance in this analysis: discretionary trips and work trips. They are described in the next few paragraphs.

Discretionary Trips

In general, discretionary trips are more sensitive to changes in fares and service levels than are work or school trips. In this analysis, discretionary trips include shopping, social, recreation, tourist, and other trips. The last three types have been grouped as other because of a lack of specific data. Work, school and medical trips were considered to be non-discretionary trips. In general, the rider has more of an opportunity to change the destination or mode of a discretionary trip than of a work or a school trip.

The number of discretionary trips by mode are shown in Table 6-1 for 1979 and 1981 to represent pre- and post-fare increase levels. The losses in trips shown in the table were estimated by applying an elasticity adjustment factor of 1.13 to the modal elasticities derived in Section 3, and the proportional change in the average fare over this time period.

Overall, 22 percent of the trips made in 1979 were discretionary trips; most were made on the rapid transit system. The fare increases and service changes between 1979 and 1981 have caused the number of discretionary trips to drop from an estimated 138,700 trips per average weekday to about 105,000 trips or roughly 19 percent of the total trips. This is equivalent to a drop of one-third. The greatest loss was in the number of discretionary trips made on the rapid transit system. The smallest loss was on the surface vehicles.

Of the 43,000 discretionary trips no longer made on the MBTA, approximately 12,000 are trips that are no longer made at all (see Appendix F for a discussion of the diversions of trips to other modes). A large portion of the remaining lost trips are probably made by driving or walking to other destinations. The number of shopping trips made on the MBTA decreased by 16,700 between 1979 and 1981. The impact of this is described in Section 6.3 for each type of rider.

Work Trips

Work trips are the least sensitive to changes in fares. In general, the average income of persons making work trips is higher than that of the overall riding population. This group is also most likely to own automobiles and can, therefore, divert to driving instead of taking transit to work if the fares become too high, or service levels too low. The riders making work trips

	Rapid Transit	Combi-nation	Surface	Total
1979				
Shopping	16,900	18,800	18,900	54,600
Social	15,900	9,600	7,600	33,100
Other	18,000	17,500	15,500	51,000
TOTAL Discretionary	50,800	45,900	42,000	138,700
% of Mode's Trips	27.9%	18.2%	21.5%	22.1%
1981				
Shopping	10,100	12,900	14,900	37,900
Social	9,500	6,600	6,000	12,100
Other	10,700	12,000	12,300	55,000
TOTAL Discretionary	30,300	31,500	33,200	105,000
% of Mode's Trips	22.6%	16.2%	18.7%	18.7%
% Change	-40.5%	-31.3%	-20.9%	-24.3%

Source: 1979 distribution derived from 1978 MBTA Systemwide Survey; 1981 figures derived by applying elasticities to the 1979 categories.

DISCRETIONARY TRIPS PER AVERAGE WEEKDAY (1979 AND 1981)

TABLE 6

were grouped into captive riders--those without an automobile, and discretionary riders--those having access to an automobile. The ridership levels are shown in Table 6-2 for 1979 and 1981. The figures for 1979 were derived form the 1978 Systemwide Survey. The 1981 levels were estimated using elasticity adjustment factors for work trips (0.69), modified for choice (1.31), or captive (0.63) riders. The proportional change in fare used was that associated with full-fare adult or prepaid pass users.

The total loss in work trips was estimated at approximately 77,400 trips per average weekday. This represents a 27.5 percent loss in total work trips. As expected, the greatest loss (58,400) was for discretionary riders; captive riders showed a smaller absolute (19,000 trips) and proportional change (-21 percent). In general, persons making work trips divert to other modes as opposed to foregoing the trip or changing work location. The latter alternative might be a long-term implication of generally rising transit fares, but is offset by changes in automobile commuting costs.

6.3 IMPACTS OF RETAIL TRADE

This section describes the impacts of the fare increase on retail trade and presents data on the number of lost shopping trips. Retail shopping trips made in 1979 and 1981 are delineated by fare type and transit mode in Table 6-3. The data presented in the table indicates a decline of 16,630 shopping trips from 1979 to 1981, or 30.5 percent of the 1979 shopping trips made using the MBTA. It can therefore be broadly concluded that the fare increase significantly curtailed discretionary shopping trips among the transit riding public.

Lost shopping trips can result in lost sales and, thus, have a negative impact on retail trade. The positive relationship between public transportation and retail sales was clearly evidenced by the one-day MBTA shutdown in December 1980. Losses in sales as estimated by downtown retail merchants totaled $6,000,000. These sales, however, were probably made in suburban shopping centers accessed by automobile. The Boston Redevelopment Authority has estimated that shoppers spend an average of $15 per trip on the average weekday. It is estimated that 5,200 lost transit shopping trips (derived by applying the ratio of shopping-to-discretionary trips to the number of trips no longer made) were not recovered by other transportation modes. This results in $78,000 in lost retail sales for the average weekday, or $23.3 million in annual sales. It is expected that 11,500 of the 16,700 lost trips do not result in lost retail sales as the trips are still made either to other shopping centers or by other modes.

The data illustrates that ridership losses were restricted to students, children and adults paying full fares. The greatest loss in shopping trips was from those riders who pay full fare.

	Rapid Transit	Combination	Surface	Total
1979				
Discretionary*	50,000	88,200	51,000	189,200
Captive**	32,200	30,500	23,700	91,400
TOTAL Work Trips	82,200	118,700	74,700	280,600
1981				
Discretionary*	30,900	61,900	38,000	130,800
Captive**	25,700	26,000	20,700	72,400
TOTAL Work Trips	56,600	87,900	58,700	203,200
Percent Change	-31.1%	-25.9%	-21.4%	-27.6%

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*Automobile owner
**No automobile

Source: 1979 trips derived from 1978 MBTA Systemwide Survey; 1981 trips derived by applying elasticities to the 1979 figures.

WORK TRIPS PER AVERAGE WEEKDAY FOR DISCRETIONARY AND CAPTIVE RIDERS (1979 AND 1981)

TABLE 6-

	Rapid Transit	Combination	Surface
1979			
Adult Full Fare	14,200	11,890	11,530
Prepaid Pass	1,000	940	920
Elderly & Handicapped	1,220	5,070	4,880
Students & Children	370	730	1,360
Other	100	140	220
TOTAL	16,890	18,770	18,910
1981			
Adult Full Fare	6,770	6,380	7,270
Prepaid Pass	1,000	940	920
Elderly & Handicapped	1,460	6,040	5,860
Students & Children	130	240	470
Other	100	140	220
TOTAL	9,460	13,740	14,740
Percent Change	-44.0%	-26.8%	-22.1%

SOURCE: 1979 distribution derived from 1978 MBTA Systemwide Survey; 1981 figures derived by applying elasticities to the 1979 categories.

SHOPPING TRIPS PER AVERAGE WEEKDAY BY FARE TYPE
(1979 AND 1981)

TABLE 6-3

The greatest percentage decline in shopping trips occurred within the student and children fare category, where ridership declined by almost two-thirds. This is attributable to the large percentage change in these fares between the two time periods. Shopping trips made by the elderly and the handicapped have probably increased as these groups now ride free between 9:30 AM and 4:00 PM. Trips made by prepaid passholders should not have changed due to the fare hike, since a shopping trip would not cost more if the pass is already bought for work trips.

Ridership loss was most pronounced among those who used rapid transit exclusively. Retail shopping trips on rapid transit declined by 44.0 percent. Losses in surface-only and combination trips were less severe, at 22.1 and 26.8 percent, respectively. This is explained in that full-fare shoppers constituted a higher percentage of rapid transit shoppers (84.0) than they did of surface only (61.0) or combination trips (63.3).

6.4 FARE BURDEN

In addition to looking at the absolute and percentage changes in ridership according to socioeconomic classifications, it is also relevant to determine the financial burden on each group associated with using the MBTA and relate that measure to the ability of each group to pay. The comparison of fares paid with cost of service for a particular mode is also of interest when addressing the socioeconomic impacts of fare policies. These issues are discussed in the remainder of this section.

In this analysis, the proportion of total household income that is spent on the MBTA is referred to as the "fare burden." It is not possible to directly determine the "fare burden per household" because recent information is not available on the MBTA usage rates per household. This analysis, therefore, derives a fare burden assuming one MBTA rider per household who makes a fixed number of trips. This enabled a comparison between different income groups and fare payments.

The proportion of household income devoted to MBTA fare payment is shown in Table 6-4 by income level and mode for 1979 and 1981. The annual fare payment per household for public transportation is also shown in Table 6-4 for the various fare payment categories (full adult fares, prepaid pass, elderly and student half fare, average system fare).

Overall, 1.6 percent of the average rider's household income was spent on the MBTA in 1981.* This compares with 1.2 percent in 1979. The figures show that riders from low-income households can devote as much as 6.5 percent of their income to using the MBTA if they use both rapid transit and surface vehices for each trip;

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*Annual figures were computed based on the post-August 1981 fare structure.

	1979			1981		
pe of Payment	Rapid Transit	Comb-ination	Surface	Rapid Transit	Comb-ination	Surface
ll Fare*	$137.50	$304.00	$191.50	$387.50	$711.50	$372.50
epaid Pass*	113.00	222.00	122.00	320.00	526.50	246.00
derly-Half Fare*	57.50	135.50	89.50	194.00	356.00	185.50
udent**	41.40	44.50	47.50	140.00	256.00	134.00
erage Fare*	120.00	250.00	144.00	300.00	494.50	227.50
an Household come(1) (Annual)	$18,400	$17,200	$15,600	$23,100	$21,600	$19,600
of Income Spent Average Fare	0.7%	1.5%	0.9%	1.3%	2.3%	1.2%
erage Low House- ld Income(1) (Annual)	$5,800	$6,000	$5,900	$7,300	$7,600	$7,400
of Income Spent Average Fare	2.1%	4.2%	2.4%	4.1%	6.5%	3.1%

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*Assumes 250 round trips/year.

**Based on 180 round trips/year.

(1) From 1978 Survey, adjusted by change in personal income from the Bureau of Labor Statistics; the income levels are probably overestimated, due to potential bias in survey for this question.

ANNUAL FARE PAYMENTS BY TYPE OF RIDER (1979 AND 1981)

TABLE 6-4

prior to the fare increases in 1980 and 1981, this figure was 4.2 percent. This implies that over 50 percent more of one's income must be spent on traveling on the surface and rapid transit lines. As much as 2.3 percent of the average user's income is spent on fare payment in 1981. This is up from 1.5 percent in 1979.

The fare increase has had a greater impact on the low-income user. Although the fare increase for both low- and high-income users had the same absolute dollar value, the percentage of income that a low-income household must spend on the MBTA is significantly greater than that of a higher income household. For instance, the fare paid over a year on rapid transit rose on average from $120/year to $300/year. The average-income household riding the MBTA must devote an additional 0.6 percent of his income to riding transit. The average low-income user must devote an additional 2.0 percent of his income to riding the transit system. The additional fare burden for the low-income rider is, therefore, approximately three times as great.

Data on the cost of operating each mode of public transportation is provided below for 1979.*

	Operating Cost (Millions)	Cost/Revenue (Vehicle) Mile
rapid transit	$106.4	$10.52
surface	106.1	3.77
- streetcar	16.4	3.19
- bus	85.8	3.86
- trolley bus	3.9	4.86
commuter rail	41.2	7.11

The data shows a large difference between the cost of operating each mile of rail service and each mile of bus service. Each vehicle mile of surface service is less expensive to operate, however, each vehicle mile of surface service also has the capacity to carry fewer passengers than a mile of rail service. Based on a national average trip length of 7.1 miles for rapid transit and 5.12 miles for surface trips, we can modify the annual operating costs by the number of passenger trips or passenger miles results in the following unit cost estimates.

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*At the time this analysis was conducted, 1979 data was the most recent available.

	Cost Per Passenger Mile	Cost Per (one-way) Passenger Trip
rapid transit	16.4 cents	$0.58
surface	16.2 cents	$0.42

The number of passenger miles traveled per year was derived through an estimate of the average length of a rapid transit or surface trip. Since recent data specific to the MBTA was not available, national data from NPTS was used. As can be seen from the figures below*, average trip length varies by mode and income of each user. In general, commuter rail trips cover longer distances than trips on other modes. Trip distance also increases with the income of the rider.

	Low Income (miles/trip)	Mean Income (miles/trip)	High Income (miles/trip)
rapid transit	6.3	7.1	8.5
combination**	8.0	9.2	12.5
surface	4.4	5.2	8.1
commuter rail	16.8	15.9	21.6
Average	5.0	6.8	11.4

**Derived by taking 75 percent of the sum of the average rapid transit and surface trip lengths.

In order to compare the fare the user pays with the cost of providing that service, values for the fare/mile, fare/trip, and cost/passenger-trip were derived by income group and mode. These are presented in Table 6-5 for 1981. Due to the longer trip lengths of higher-income riders, their fare per mile traveled on the MBTA is less than that paid by lower-income persons. The total cost associated with providing the trips to higher-income groups is greater, again due to the longer trip length. A detailed distance-based fare structure would alleviate some of the inequities associated with the broad zonal fare structure

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*SOURCE: 1977-1978 NPTS data in "Socioeconomic Characteristics of Transit Riders: Some Recent Evidence," J. Pucher, et al, Traffic Quarterly, Volume 35, Number 3, July 1981.

	Fare/Mile* 1981 (Cents)	Fare Per Passenger 1981 (Cents)	Operating Cost Per Passenger Trip** (Cents)
Low Income			
Rapid Transit	9.5	60.5	103.3
Combination	12.4	98.9	130.4
Surface	10.3	45.5	71.3
Mean Income			
Rapid Transit	8.5	60.0	116.4
Combination	10.8	98.9	150.0
Surface	8.8	45.5	84.2
High Income			
Rapid Transit	7.4	60.0	139.4
Combination	7.9	98.9	203.8
Surface	5.6	45.5	131.2

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*Uses average fare.
**1979 cost data.

SOURCE: 1981 data was derived from the results of the 1978 Systemwide Survey.

FARE PER MILE AND COST PER TRIP BY INCOME AND MODE

TABLE 6

currently used on the MBTA. It should be noted that the actual cost of providing service varies by rapid transit line and bus route, and to the time of day that service is bring provided. To derive the true marginal cost of carrying specific groups of riders, more detailed breakdowns of costs, which are currently unavailable, would be needed.

6.5 SUBSIDY PROGRAMS

As was demonstrated from the operating cost figures and the sources of MBTA revenue in Section 2 of this report, fares cover only a small proportion of the total cost of service. MBTA passengers are subsidized either directly by the MBTA or indirectly through taxpayer assistance.

6.5.1 Direct MBTA Subsidy Programs

The MBTA currently provides direct subsidies to several groups of users: the elderly, handicapped, students, and children. The level of subsidy and the regulation of law requiring it is provided in Table 6-6. The cost to the MBTA of providing the subsidy is also noted. These programs are described in the following paragraphs.

Elderly

Any person 65 or older, who is a resident of a community within the MBTA district, is eligible to ride the MBTA for free between 9:30 AM and 4:00 PM, Monday through Friday and for half fare at all other times. A senior citizen identification card, available from the MBTA, must be presented to the fare collector. State law (MGL, Chapter 161A, Section 5e) requires that half fares be offered to the elderly at all times. The MBTA Board of Directors and the MBTA Advisory Board approved the free-fare structure for off-peak travel. It should be noted that the Urban Mass Transportation Administration (UMTA) also requires that transit authorities receiving UMTA financial assistance make their facilities available to elderly for half the free fare during off-peak time periods.

The cost to the MBTA of providing free fares to the elderly is approximately $5.0 million more per year than if half fares were charged at all times.* If full fares were collected for all the elderly trips currently made, annual revenue would be approximately $12.3 million. The MBTA currently collects $2.7 million annually from its elderly riders, implying that the subsidy program is costing the MBTA $9.6 million in lost revenue alone. Additional costs are incurred in processing identification cards.

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*These figures assume no loss in riders.

	Fare	Citation	"Lost" Revenue Due to Subsidy Program
Student and Children	half fare	MGL Chapter 161A, Section 5e	$4.0 million
Elderly	half fare	MGL Chapter 161A, Section 5e	$9.6 million
Blind	free fare	MGL Chapter 6, Section 135	Not Available
Children 5 and Under	free fare	MGL Chapter 161A, Section 5e	Not Available
Handicapped - Off Peak	half fare	UMTA Regulation	Not Available
Elderly and Handicapped 9:30 to 4:00 PM (M-F)	free fare	Executive Order and Approval of MBTA Board of Directors and Advisory Board	$1.6 million*
THE RIDE	75 cents	UMTA Regulation - Minimum 2% of Section 5 money used on special programs - 1982 Operating Costs - $1,043,000 EST Trips - 80,000	$1.0 million

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*Difference between half fares and free fares.

Source: MBTA; estimate of "lost" revenue derived by CTPS.

Handicapped

Handicapped persons ride regularly scheduled MBTA service free between 9:30 and 4:00 on weekdays; pay full fares during the peak period, and half fares at all other times. UMTA regulations require that the MBTA offer half fare during off-peak times. Blind persons are carried free at all times as required by MGL, Chapter 6, Section 135.

In addition to the regularly scheduled service, a demand responsive service, called The Ride, is provided for a base fare of $.75. Operating costs of The Ride in 1982 are estimated at $1,043,000; revenue is expected to be $60,000.

Children and Students

Upper limits for children and student fares are set forth in MGL, Chapter 161A, Section 5e, which states that children between 5 and 11 pay half fare at all times, and children less than 5 ride free. Students aged 12 through 18 (through high school) pay half full-fare for school or school-related trips upon showing a valid student badge.

The MBTA subsidizes school trips by approximately $2.8 million per year. If children and student half fares were increased to full fares, the MBTA could take in an additional $4 million in increased revenue. There is no accurate way of determining the extent of travel by children under 5 years of age, and so the level of subsidy for this group alone cannot be estimated with any precision.

Other Subsidies

The MBTA also provides free access to the system to its employees. These riders, grouped with children less than 5, comprise approximately 3 percent of total daily riders. On an annual basis, this translates into a cost of $3.3 million. Fare evaders using the MBTA cost of MBTA approximately $440,000 per year in lost revenue.

6.5.2 Indirect Subsidy Programs

As described earlier, the MBTA receives financial operating assistance from several sources: the federal government, state government, and local cities and towns n the MBTA district. For 1980, the state's assistance amounted to 53 percent of total taxpayer assistance, local cities and towns paid 36 percent, and the federal government contributed approximately 11 percent (see Figure 2-12). In recent years, the state's share has been increasing both as a proportion and in absolute magnitude. All of these funds ultimately come from the taxpayer. The sources of taxes--whether the federal income tax, state income tax, gasoline tax, or local property tax--determine who, in effect, pays for the indirect subsidies to transit.

The question of who is subsidized by transit operations and the equity and efficiency implications of current operations have been studied extensively by several individuals and organizations.* The general conclusions have been that transit subsidies promote income redistribution from higher- to lower-income persons, but that changes could still be made in the pricing structure on transit systems to further enhance the benefits to low-income users. A review of the tax burden associated with the sources for the subsidies shows that the portion of assistance from the federal government is the most progressive (i.e., higher-income groups contribute a greater proportion of their income for the tax). In general, the federal income tax and the corporate taxes constitute the greatest portion of the federal tax revenue.

The state's share of the transit subsidy is paid for by taxes from various sources, among them are the state income tax, sales tax, gasoline tax, business tax, and cigarette tax. These taxes tend to be more regressive than the federal taxes. The greatest portion of the transit subsidy comes from these sources. The local contribution is from revenue generated by the local property tax, which is generally considered to be more regressive than the state or federal taxes.

Quantification of the "tax burden per household income", specific to the MBTA's subsidies and Metropolitan Boston population is outside the scope of this analysis, as is a detailed description of the incidence of the various local and state taxes.** A study of the transit tax payments per household using 1978 national data estimated that low-income households (less than $6,000) pay between $20 and $26 for transit taxes, while high-income households ($25,000+) pay between $147 to $185.*** Low-income households pay approximately 3 to 4 percent of the transit subsidies, whereas high-income households pay approximately 50 percent of the subsidies.***

In summary, both the direct and indirect subsidy programs of the MBTA have the net effect of providing an income redistribution from the higher- to lower-income households in the Boston area.

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*Two recent works used in this analysis are:

1) "Equity in Transit Finance, Distribution of Transit Subsidy Benefits, and Costs Among Income Classes," John Pucher, *Journal of the American Planning Association*, October 1981.
2) U.S. DOT, UMTA, R. Cervero, et al, "Efficiency and Equity Implications of Alternative Transit Fare Policies," September 1980.

**The reader is directed to an unpublished study (available at CTPS) by A. Palmere, "Alternatives for Financing the MBTA," April 1981, prepared for the League of Women Voters, for one set of Boston-specific data.

***Pucher, J., "Equity in Transit Finance," *Journal of the American Planning Association*, page 402.

6.6 SUMMARY OF SOCIOECONOMIC IMPACTS

This section has presented a review of the impacts of the recent fare increases on various groups of users. Since the implemented fare structure provides for free off-peak travel by elderly and handicapped persons, some of the adverse socioeconomic impacts associated with an increase in fares were mitigated. Increased fares typically affect the elderly more severly than other groups, as they tend to be living on fixed incomes and tend to be more dependent upon public transportation.

As expected, the fare increase affected low-income riders to a greater extent than higher-income groups. Depending upon the mode used, one individual from a low-income household could spend between 3 and 7 percent of his household income on the MBTA. This compares with 1 to 2 percent of the annual income for the average-income household. Fewer trips were lost from this group of users, as compared with other groups, as they tend to have fewer alternative means of travel and so they now comprise a larger proportion of daily ridership. Discretionary trips, such as shopping or social trips, experienced the greatest proportional loss, although the number of work trips declined by the greatest amount. Most of these work trips were made by commuters who had an automobile for their use. It is expected that almost one-third of the diverted discretionary trips are no longer made, whereas most other tirps are still made, but by using alternative modes.

Two measures are identified which could mitigate the socioeconomic impacts of the fare increase. One would be to provide a subsidy program to the MBTA's low-income riders. This type of program is described in Section 7. A second measure which could make the fare structure more equitable would provide a distance-based fare structure, possibly modified by time-of-day pricing, as well. This type of program has been addressed in the alternative section and would require a more automated fare collection system than currently is in place on the MBTA. A fare structure that varied according to distance traveled and reflected the relative cost of traveling at a specific time of day would more equitably charge users for the cost of carrying them than does the current zonal fare system. In this manner, fare changes could be more gradual and would tend to minimize the loss in riders and maximize the increase in revenue by assigning prices according to the service used.

This analysis has also developed a series of elasticities disaggregated by mode, time of day, user income level, and trip purpose specific to the MBTA. They are provided in Table 6-7 and could be used by the MBTA in the future to project the relative impacts of fare policy changes on various socioeconomic groups. In this manner, the MBTA might more closely gauge the revenue and ridership impacts of new fare policies.

	Rapid Transit	Combination	Surface
Aggregate Elasticity	-.24	-.28	-.32
Time Period			
- Off Peak	-.33	-.39	-.44
- Peak	-.14	-.17	-.19
Trip Purpose			
- Shop	-.27	-.32	-.36
- Work	-.17	-.19	-.22
Ridership Type			
- Choice	-.31	-.37	-.42
- Captive	-.15	-.18	-.20
Low Income	-.17	-.20	-.23
Age			
- 1 to 16 years	-.33	-.38	-.44
- 65+	-.14	-.17	-.19

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*Derived from changes observed for Boston between 1979 and 1981, and disaggregate factors reported in U. S. DOT report prepared by Ecosometrics.

DISAGGREGATE FARE ELASTICITES*

TABLE 6-

In order to determine the social or economic impacts of fare policy and service changes for specific geographic areas within the MBTA district, more disaggregated data is necessary. The data from the 1978 MBTA Survey is not at a level of significance such that information on the socioeconomic characteristics of individual bus routes could be used. As 1980 census data becomes available, the base data used by the MBTA to evaluate the impacts of service changes on bus routes (e.g., density of low income or minority populations in communities through which the buses travel) should be updated. In this manner, the effects of bus and rail service changes to various socioeconomic groups of users could be more closely identified.

7.0 MITIGATING MEASURES

The option of increasing base fares for transit service is but one alternative to be used to raise additional revenue. The MBTA is implementing and further investigating several measures which would lessen the adverse impacts of the fare increases and service reductions on the public, as well as looking at alternatives to this action for future consideration. Both of these categories are described in the remainder of this section. In addition, for mitigating measures, information on the MBTA level of commitment and schedule of completion is provided.

The MBTA is actively implementing a number of measures which are designed to lessen the adverse impacts of the fare increases and service reductions on the public. These measures support the MBTA policy of increasing ridership while working to balance the overall financial burden among riders and public revenue sources. Furthermore, a listing of mitigating measures which will be accomplished and a schedule of completion is a required portion of the work scope.

Many of the mitigating measures suggested are at a secondary level of addressing services and operational issues which, in turn, affect the ability of the MBTA to control costs and increase ridership. Finally, a number of management issues addressed in the Management Practices Report are included here, although they are not discussed in detail in this report. These are presented to aid the reader in gaining a uniform understanding of the MBTA's scheduled commitment to mitigating the impacts of the fare changes.

7.1 SERVICE

7.1.1 Service Restoration

The increase in budget allocations for the Transportation Department of the MBTA allowed for the staged restoration of selected services during the fall of 1981 as well as additional restoration during 1982 and 1983.

The following is a summary of the service restoration/improvements made to restore ridership and provide better service:

Fall 1981

- Sunday evening bus service hours extended from 7:00 PM to 11:00 PM

Fall 1981 (cont.)

- Route 430A - peak hour service restored
- Route 97 - midday service restored
- Route 72 - midday service restored
- Route 458 - all-day service restored
- Headway (service frequency) Improvement or Trip Time or Routing adjustments on two dozen routes.

Winter 1982

- Headway Improvement or Trip Time or Routing adjustment on ten routes
- Route 130 - full midday service restored
- Route 212 - service Monday-Saturday restored

Spring 1982

- Downtown Crossing service restored
- Headway Improvement or Trip Time or Routing adjustments on ten routes
- Route 78 - service restored to Park Circle
- Route 90 - all-day service restored; route now services Assembly Square Mall
- Sunday evening service hours extended to 1:00 AM on all modes

Summer 1982

- Arborway Streetcar Service Restored
- Route 92 - service extended to serve Assembly Square

Fall 1982

- Route 44 - service extended to Franklin Park main gate
- Route 55 - service extended to Park Street Station
- Route 112A - service initiated
- Headway Improvements or Trip Time adjustments on more than two dozen routes

Winter 1983

- Evening service headway improvements on seven routes
- Route 3 - new route implemented
- Route 9 - all trips service Copley Square
- Route 16 - extended to service Forest Hills to UMASS during peak hours only
- Route 21 - Saturday service restored
- Route 47 - short-line operation between Dudley and Longwood Medical Area implemented
- Route 302 - Midday and Saturday service implemented
- Route 411 and 430A - combined to create new crosstown bus route
- Sunday service improved on 26 routes and restored on seven routes
- Headway Improvements or Trip Time adjustments on more than one dozen routes

Spring 1983

- Route 101 Sunday service extended to Malden Center
- Route 225 - AM peak trips routed via Shaw Street
- Route 350 - service to Burlington Mall initiated
- Headway Improvement or Trip Time or Routing adjustments on more than one dozen routes

7.1.2 Service Quality Improvements

Service quality improvements are being addressed through a multiplilcity of ongoing programs. Among these are equipment replacement and restoration, power distribution system restoration, signal system replacement, communications system expansion, and track replacement. Operational improvements include the provision of equipment maintenance and service evaluation systems.

Collectively, these improvements will reduce the number of incidents of system failure, and thereby increase reliability. Details of these programs with the MBTA's commitment to these programs follows:

A. Surface Traffic Improvements

Various efforts to improve the flow of buses and surface rail (Green Line) vehicles have been and are under consideration. In recent years, the number of bus stops have been reduced, and the remaining stops have been lengthened and clearly marked with signs. Additionally, bus lanes have been establilshed in downtown Boston as part of the Downtown Crossing Project. There also exists the bus/carpool or multiple-occupancy vehicle (MOV) lane on I-93 southbound, north of the interchange with Route 1.

On the surface rail lines (Green Line), the number of stops have been reduced, new passenger platforms constructed and intertrack fencing installed. These measures reduce the number of surface rail vehicle pedestrian conflicts and increase travel speeds. Work on Beacon Street and Huntington Avenue (Tunnel portal to Brigham Circle) and a part of Commonwealth Avenue have been completed. Improvements to the remainder of Commonwealth Avenue (Brighton to Warren Street) are being undertaken in 1983.

In conjunction with transit station construction, preferential treatment for buses is provided in the station area. Examples now in design or construction include the reconstruction of the bus tunnels at Harvard Station, exclusive bus lanes at Alewife and Davis Stations on the Red Line, and a busway at Ruggles Station on the Orange Line. A bus lane on Atlantic Avenue in Boston is proposed in conjunction with South Station area roadway improvements.

The City of Boston is near completion of design of a computerized signal system which will, in addition to providilng centralized signal control, provide for signal preemption for Green Line vehicles on Commonwealth Avenue and Huntington Avenue. The schedule for advancing this system to implementation is contingent upon availability of funds.

In conjunction with the Boston effort, the MBTA plans to install signal preemption equipment on the South Huntington/Centre Street segment of the Arborway Line.

In a study to consider replacement transit service in Boston's South End and Roxbury in the area of the Orange Line Elevated, alternatives of surface rail and bus in exclusive transit rights-of-way on city streets are being considered. Among these alternatives are surface rail on Washington and Tremont Streets between Dudley Street and South Cove, and buses on Washington Street, Dudley Street and Melnea Cass Boulevard.

The study effort and a decision to advance service improvements are scheduled for completion in 1984.

The MBTA has investigated the potential for additional bus lanes in the inner-city areas. Unfortunately, these investigations were unsuccessful in identifying bus lanes with high potential for implementation.

B. Equipment Replacement and Restoration

1. The bus replacement program consists of purchase of an average of approximately 100 buses each year to maintain an average fleet age of six years. Bids are being sought for procurement of 20 articulated buses in 1983.

Also in 1983, consideration is being given to procurement of additional buses and/or rehabilitation of a portion of the existing fleet.

2. Acquisition of new cars for the Orange (120) and Blue (70) Lines was completed in 1982. In addition, the purchase of 58 Red Line cars is scheduled for bid in the fall of 1983. Vehicles will be scheduled for delivery in 1986.

3. Green Line LRVs are being slated for reconstruction, including general vehicle modifications to insure the durability of these vehicles.

4. A major upgrading of the existing facilities used to house and maintain the vehicle fleet is in progress. A replacement facility for the Riverside Carhouse is under construction. Renovation of Quincy and Lynn Bus Garages is scheduled to begin in 1983, as is minor rehabilitation of the Albany Street Garage.

C. Electrical Power Improvements

Several efforts are underway to modernize and upgrade the present capabilities of the MBTA's power system. These efforts include:

1. Conversion from the obsolete 25 hertz (Hz) power system to a centrally connected 60Hz system. As of mid-1983, two switching stations and seven power substations had been converted. Conversion of the remaining eight substations is scheduled for completion by the end of 1984.

2. Resectionalization of the AC/DC feeder cables between substations and tracks. Design of this program is scheduled for initiation in 1983-1984.

3. Power cable replacement of deteriorated cable ducts. This multi-year program is approximately 20% complete. The remainder of the program is scheduled for completion in 1987-1988.

D. Signals and Communication Improvements

A program has been advanced for the renewal or replacement of deteriorated or substandard signal equipment on the Red, Blue and Green Lines. The Red Line signal program is under construction and scheduled for completion in 1984. The Blue Line signal program is expected to begin in 1984 and the Green Line in 1987.

Included in this program are:

1. The installation of communication cable. This program is scheduled to proceed concurrently with signal installation.

2. The installation of an emergency telephone system. This program is also scheduled to proceed concurrently with signal installation.

3. Computer-aided bus radio system. Design funds are being sought in 1983. Installation is expected in 1985.

4. Completion of an MBTA/police radio system in the Authority's tunnels. This element is currently being installed and is scheduled for completion in 1984.

E. Track and Structural Improvements

A multi-year track renovation program in which all deteriorated and substandard track on the Green Line and the three rapid transit lines will be renewed or replaced. Major track improvements are proposed on the following lines:

1. The Blue Line (Airport to Wonderland). This project will be completed in 1983.

2. Green Line rights-of-way and track bed rehabilitation. The Riverside, Arborway and Beacon Street rights-of-way have been renovated in recent years. Commonwealth Avenue is being completed in 1983. The Green Line Central Subway track rehabilitation is scheduled to take place in phases over a number of years with the first phase (Haymarket Portal to Park) scheduled for initiation in 1984.

F. Station Renovation Projects

A number of station modifications and renovation projects have been proposed and are in various stages of planning and implementation. Among the projects currently being proposed are:

1. Columbia Station - Enlargement and renovation. A design consultant contract is currently being negotiated. Construction is scheduled for 1984-1985.

2. Kendall Square - Modernization, enlargement and improvements to the station and platform. Final design is scheduled for completion in 1983, with construction scheduled for 1984-1985.

3. Platform lengthening to accommodate six-car trains at Washington, Park Street (Red Line portion), South Station, Central Square, Broadway; and on the Blue Line, the Suffolk Downs Station. Suffolk Downs platform lengthening is scheduled for construction in 1983; Central, Park and Washington for 1984; and Broadway and South Station for 1985.

G. The Maintenance Program

A program to provide preventative maintenance and thus reduce operating costs, increase revenue and productivity, and also improve safety and service quality has been proposed. This program includes the provision of test equipment, shop tools, machinery, etc., as well as a sufficient quantity of spare replacement parts to maintain a high level of vehicle availability and regularly-scheduled inspections.

Collectively, the purpose of improvements such as these is to reduce the number of incidents of system failure and, thereby, improve service reliability.

For all passenger equipment, a formal program for vehicle inspection has been established. Adherence to the inspection program is reported on and monitored on a monthly basis. Normal regularly scheduled maintenance is performed in conjunction with the inspection program.

The MBTA is currently developing a system for programmed maintenance of rapid rail equipment. The system provides for scheduling and availability of replacement parts. This system is scheduled to be in operation by the end of 1983.

On the Green Line, the present focus is on undertaking a program to rehabilitate the existing Light Rail Vehicle fleet. It is felt that an effective preventive maintenance program should be considered after the fleet rehabilitation has been completed.

At the Cabot Bus Garage, vehicles are being assigned to operators and mechanics on a test basis. It is felt that continuous assignment of vehicles to the same employees may engender greater pride in maintaining equipment.

7.2 PLANNING

7.2.1 Service Planning Staff Increases

Management review of staff increases in the Service Planning Group as recommended by Touche-Ross is in process.

7.2.2 Revisions to the Service Committee

The MBTA Service Committee was reactivated in 1982. The Committee consists of representatives of Service Planning, Operations Planning, Schedules, Transportation (Surface Lines) and Customer Services. There are currently no plans to change the Committee.

7.2.3 Revision of 1977 Service Standards

Recommendations on revisions to the Service Standards are being developed through the MBTA's Bus Service Evaluation (SENTRY)

Project. A final report is scheduled for completion at the end of 1983.

7.2.4 Automation of Simple Service Planning Functions

A TRS-80 micro computer was installed early in 1983 for Service Planning staff use. Service Planning staff is currently participating in an APTA-UMTA Productivity Program to assist in the development of applications for the micro computer.

7.2.5 Improvement of the Planning Data Base

The Central Transportation Planning Staff is establishing a staff group to support the MBTA Service Planning Office in maintaining a comprehensive data base for service planning.

7.3 EFFICIENCY

7.3.1 Preventive Maintenance

The status of preventive maintenance programs is described in Section 3-F under Service.

7.3.2 Fuel Consumption Reviews

The Authority established an energy conservation program in mid-1979. This program includes, among other functions, the close monitoring of all energy use and cost for each of several hundred separate billing locations on both a monthly and annual basis. Since the monitoring is done manually and is extremely time consuming, efforts have been underway to computerize the process as part of the overall management information system being developed for the Operations Directorate by ATE Management and Service Company. This effort should be completed in 1984; however, this waiting period will not adversely affect current efforts in tracking energy use.

There are two basic objectivees for improving energy efficiency of the MBTA. The first and most important is modernization of the power supply which includes the conversion of the obsolete 25 hertz (Hz) power substations to 60 Hz power and the phasing out of MBTA self-generated 25 Hz power. The power supply system modernization effort is nearing completion and the results through 1982 indicate that the gross energy consumed in supplying the total electric power needs of the system has declined steadily from 3.6 billion British Thermal Units (BTUs) in 1978 to 2.63 billion BTUs in 1982, while the number of electric vehicle car miles increased from 15.9 million to 17.5 million.

The net result is a 51% improvement in gross energy consumed in supplying the total electric needs of the MBTA. The number of car miles operated per million BTUs of gross energy increased from 4.4 in 1978 to 6.658 in 1982. The gross energy decline from

3.6 billion BTUs in 1978 to 2.63 billion BTUs in 1982 represents a savings of 976,261 BTUs, which is the energy equivalent of 6.52 million gallons of residual (No.6) fuel oil.

The second basic energy conservation objective of the Authority is to enhance the energy efficiency of the operating system in terms of net energy input to the operating system per car mile operated. The net electric energy supplied to the operating system per car mile operated remained nearly constant, varying from a high of 14 kilowatt hours/car mile (KWH/CM) in 1981 to a low of 13 KWH/CM in 1982. The 13 KWN/CM in 1982 represents a significant improvement considering the introduction of a new fleet (190 rapid transit cars) on the Blue Line in 1979 and on the Orange Line in 1981, which consumed significantly more energy per car mile than the older equipment which was replaced.

The policy of the Authority is to continue efforts to monitor and improve the energy efficiency of the system by various measures which are economically sound. A major five-year program of capital improvements aimed at improving the energy efficiency of the rolling stock and fixed plant was developed in 1980 and is currently awaiting capital funding approval which is expected in 1984. A capital grant application was also submitted to the Urban Mass Transportation Administration (UMTA) requesting capital funding to begin converting the Green Line fleet of the Light Rail Vehicles to regenerate power and greatly improve the energy efficiency of the Green Line.

In addition to the reductions in electric system energy consumption, the amount of energy consumed by the fixed plant heating systems declined from 516,090 million BTUs in 1978 to 446,662 million BTUs in 1982, which is the equivalent of 500,000 gallons of No. 2 oil saved in 1982.

Automotive fuels have also declined from 7,586,603 gallons (diesel and gasoline) in 1978 to 6,538,510 gallons in 1982. (The 1 million gallon reduction is attributed to reduced bus mileage.)

7.4 MANAGEMENT

7.4.1 Management Rights

Effective use of the management rights provision of Chapter 581 has been an ongoing effort since the Federal Appeals Court affirmed the Acts' legalilty in October 1981. Appendix A-6 outlines those major actions that have been taken by the Authority through March 18, 1983. Additional actions under Chapter 581 will be considered on a continuing basis.

7.4.2 Management Information Systems

During 1982, the MIS Department was upgraded to the status of a Directorate, reflecting its importance. Also in 1982, a contract was signed with ATE Management and Service Company, Inc. to design a comprehensive MIS for the Authority's maintenance departments. This work is still proceeding.

7.4.3 Ridership Information Collection

The annual revenue/rider sampling program initiated in 1981 in support of the analysis of the fare increase was repeated in 1982 and is planned for continuation on an annual basis.

The Bus Service Evaluation Study (SENTRY) Report, which is scheduled for completion in late 1983, will identify methods for improved data collection. Alteration of data collection techniques will be reviewed at that time.

7.4.4 Performance Evaluating System

A system for measuring the performance of four major MBTA departments has been established. The four departments are: Transportation, Automotive Equipment, Rail Equipment and Engineering. The system is presently being refined to establish measures that are most helpful to Department Heads in monitoring and improving performance.

7.4.5 Management Practices Study

The Management Practices Study was completed on October 29, 1982.

7.4.6 Operator Work Rules

The MBTA's Transportation Department has established a Transportation Management Improvement Plan Task Force. The Task Force, which is comprised of Transportation officials, will work closely with the MBTA's Budget Office and others.

As implied by its name, the purpose of the Task Force is to develop a Transportation Management Improvement Plan. Among other things, the Task Force will address:

- Improved service delivery through reduction in dropped trips and improved appearance of employee uniforms.

- Improved management control through a "management by objectives" approach and utilizing improved Management Information Systems.

- Improved manpower utilization through hiring practices, training and development, work rules and assignment.

The Task Force's rcommendation, which will be made on an ongoing basis, will be advanced for further evaluation, policy action or implementation, as appropriate.

7.4.7 Productivity Measurement

In order to operate productively, the MBTA must obtain and use data on a regular basis which reflects the operating conditions.

A. Daily Service Report

The basic tool used for productivity measurement is the Daily Service Report. This report details the number of scheduled trips and the number of missed trips on a daily basis. These reports are summarized on a monthly basis in an effort to track service over time. Additionally, reports are prepared in specific areas such as customer complaints, overtime, and absenteeism to monitor service and achievement of management objectives.

B. Service Policy

Performance criteria for service (bus and surface rail) operations are described in the Service Policy for Surface Transportation.

The contents of the Service Policy are prefaced by a series of service goals and objectives towards which the MBTA strives. This is followed by a number of standards and guidelines for initial service design, operating performance standards, and economic, social, and environmental standards. This section describes the standards which guide evaluation of existing services and those for planning new or modified services. The service standards which have been adopted may be divided into service design guidelines (for new or modified services) and operating performance standards (for evaluating current services). A complete and detailed listing of these standards may be found in the MBTA Service Policy for Surface Public Transportation; however, examples of the standards are briefly shown below:

Examples of Service Design Guidelines include such items as:

a) Spatial Guidelines: Service provision based on population density by walking distance to transit services,

b) directness of services,

c) route deviations,

d) service frequency criteria, and

e) routing and market feasibility.

Examples of operating performance standards include:

a) Schedule adherence,

b) service dependability,

c) speed,

d) load factors, and

e) customer complaints.

Additionally, there are a number of economic and productivity criteria, e.g., passengers-per-hour and revenue-per-passenger mile, that measure economic viability of routes. The Service Policy establishes principles and a generalized procedure for service evaluation which will be effective in bettering the quality of service and the use of available evaluation resources. The role definitions and responsibilities of various departments of the MBTA are outlined and a flow chart has been established to make a more definitive procedure available for evaluating surface transit.

C. Data Collection

Consistent and accurate data collection to determine operating efficiency and ridership levels is a need now being recognized in large and small transit authorities in the U.S. and abroad. The MBTA's current practice of estimating ridership based on the average fare is not unique with respect to other transit authorities. In the absence of better data, this method has provided the MBTA with reliable enough information in the past. However, as operating costs rise in an inflationary spiral and government subsidies for transit decline, operating efficiency becomes the critical variable for all transit authorities.

A review of data collection techniques* in 1979 showed that many other transit authorities were shifting to more detailed data collection techniques, or at least investigating the possibility. Automatic passenger counting systems are being tested in several cities and the eventual application of high technology information systems management seems inevitable. Until automated evaluative processes evolve, other transit properties are using service standards or criteria as a measure of efficiency: schedule adherence, travel time, load factors, etc. These evaluation measures generally require a staff of checkers to record levels of service or ridership for evaluation. Montreal, for example, employs 49 checkers to collect and analyze data. In 1978, the budget for this program was $950,000. The Montreal system checkers count peak loads on all bus routes five times a year, and it is the only system to conduct regular origin-destination counts.

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*Bus Service Evaluation Procedures: A Review--Short-Range Transit Planning, UMTA-DOT, March 1979.

More exact measures of efficiency and ridership levels were achieved in Pittsburg and Minneapolis-St. Paul, where bus drivers on each route must record revenue and riderhsip. Winnipeg's transit authority has had drivers punch timeclocks at selected transit stations to evaluate headway times. These examples are the exception, however, as most systems use sampling techniques.

The most elaborate system used to evaluate service is that of the Southern California Rapid Transit District (SCRTD) which began using a 40-person checking program in 1975. By 1979, the $1 Million/year program evaluated service and ridership in comparison with accepted criteria. Recommendations from the evaluation resulted in a reduction of 11 million vehicle miles with little loss in ridership and $20 Million annually in savings.

The MBTA is seeking to employ some of the techniques used by SCRTD in its evaluation program, including a model for determining fare mix and ridership characteristics.

In order to measure performance against standards on a ongoing basis, an improved data base is necessary. The MBTA, through its "Ridership and Fare Mix Sampling Program," has established a means to improve and update its data base. Also included in the Authority's efforts to further augment its data collection capacities is the computer-based bus Service Evaluation/Transportation Reporting System (SENTRY), which will collect and summarize information regardilng ridership, revenue, service reliability, and customer complaints.

The objective of the ridership and fare mix sampling program is to define and estimate ridership using revenue data. Due to the new fare structure established in August of 1981 which has provisions for elderly and handicapped to ride free during designated hours, the previous estimate of average fare was no longer valid. This program was designed to quickly and inexpensively obtain reliable estimates pertaining to the number of riders on the MBTA, the fare mix, and the average fare being paid by these riders. Through a sample of riders on buses, trackless trolleys and at Green Line and rapid transit stations, a sample of November 1981 riders was conducted. The MBTA intends to conduct a similar sample in November 1982 and perhaps annually thereafter to observe ridership trends.

The computer-based bus evaluation system, known as SENTRY, is organized into three basic modules: 1) Marketing Data Base--information on ridership and revenue characteristics; 2) Transportation Reporting--field reports on the supply of bus service including service reliability and schedule adherence; and, 3) Complaints--MBTA records of consumer complaints utilized by SENTRY as a check on Transportation Reporting and to provide insights on route trends and variations.

It is expected that SENTRY will prove to be a most useful management tool to the Authority. Presently, the Authority collects a massive amount of bus service data. While some of the data is summarized, much of it is left in its original state and stored. The data report summaries which do reach management are often received too late to be acted upon. Management requires that bus service data be refined and summarized in a timely fashion if it is to be used as a basis for decision making.

In an effort to obtain better data, the MBTA is investigating a program to expand use of electronic pass readers to include surface vehicles. The Electronic Pass Reader Program is already in place at rapid transit stations and is being installed on a trial basis on selected bus routes.

In order to derive the full benefits from the Electronic Fare System, it must be extended beyond rapid transit to the entire surface fleet. This will allow the MBTA to achieve a true intermodal fare collection system, providing the Authority with reliable statistics, and the passenger with one ticket to transfer from mode to mode.

The surface equipment, as well as the entire program, will maintain flexibility to allow for technological developments and changes in fare levels. It is also designed to be compatible with rapid transit equipment for ease of maintenance and better inventory control, and to facilitate use of remote data collection and monitoring to give a total audit trail on a daily basis.

When fully implemented, the completed system will be composed of Data Storage units which will keep the daily information at each subway station and surface vehicle location, and would in turn be linked to a central processing unit using existing phone lines. The Authority's passenger traffic flow and revenue monitoring system will consist of utilizing contacts of solenoid (passenger flow monitoring) in the turnstiles and fare boxes which interface with the MBTA's own patented card readers. A data acquisition module will then transmit data to the central processing unit.

The Authority, after full installation and implementation, will have the means to accurately count all passengers and the ability to provide more accurate information for scheduling, safety and security. In the interim, the sampling techniques used to evaluate ridership levels are the best available methods. A significant portion of the annual operating budget, however, should be set aside for data collection and evaluation of ridership levels and operational efficiency. The SCRTD sets aside one-half of one percent of that Authority's operating cost for data collection and saved that figure many times over due to higher efficiency.

A summary of progress is being made in advancing efforts to improve productivity measurement on several fronts:

- Operations Performance
- Executive Personnel Evaluation
- Daily Service Reports and Service Tracking Reports
- MBTA Service Policy for Service Evaluation
- Bus Service Evaluation (SENTRY)

Performance measures have been developed for four Operating Departments: Transportation, Automotive Equipment, Rail Equipment and Engineering. Reports on the performance of these departments, which are produced monthly, are being refined.

The personnel evaluation procedure has been revised to identify manager objectives as a means of measuring productivity.

Daily service reports and service tracking reports provide basic information on service provided each day, such as number of scheduled trips made and reasons for not making scheduled trips.

The "Service Policy" establishes service criteria for surface transportation, while the Bus Service Evaluation Study consists of a review of those goals and establishment of a service performance measurement.

As each of these and other productivity measurement efforts advance, it is expected that they will become integrated into a comprehensive system. An important unifying element in the melding of these productivity measurement efforts is further development of the management-by-objectives based personnel evaluation efforts.

7.4.8 Manager Evaluation Process

The four major operating departments (Rail Equipment Maintenance, Automotive Equipment Maintenance, Engineering and Maintenance, and Transportation) have been working on developing performance indicators for their respective departments. Over the long-term, a review of these performance indicators can hopefully be included as part of the manager evaluation process. All four departments should have their performance indicators finalized by mid-1983. Integration into the manager information process can take place at that point, but no firm timetable has been established. Some departments, notably Automotive and Rail Equipment, are far enough along in the development of performance indicators so that integration into the manager evaluation process may begin earlier than mid-1983.

The personnel evaluation process for executives has been redesigned to establish performance measurement within the context of a management by objectives process. Top executives have attended one of four training sessions in implementation of the process.

In order to coincide with the MBTA's budget process, all executive performance evaluations have been rescheduled to take place in June of each year.

To assure that the manager evaluation process is followed correctly, the Personnel Department has been assigned responsibility for monitoring the process. The process also provides for progress reviews every calendar quarter and identification of management action for unsatisfactory performances, including further training, reassignment and termination.

Appendix A-8 includes a copy of the revised Executive Performance Appraisal Form, Annual Performance Planning Worksheet and Executive Salary Review Report. These documents have been developed for executive performance appraisals within a management by objectives process.

7.4.9 Maintenance Staff

The MBTA has hired 30 out of a scheduled 39 third class mechanics (automotive) to replace first and second class mechanics now performing fueling. The first and second class mechanics have been reassigned to do bus maintenance and repair. The final nine third class mechanics should be hired within the next several months.

In addition to this staff realignment, the MBTA is placing additional emphasis on preventive maintenance. The monthly Performance Indicators, started recently for Rail and Automotive Equipment Maintenance, give some sense of this emphasis with the inclusion of inspections as a specific goal.

Cleaning of buses and the Blue Line stations, Green Line stations, Red Line (Washington to Harvard), and Orange Line (Washington to Oak Grove) are being done through contracts. This portion of work was selected for contracting on a cost-saving basis.

8.0 MBTA EXPECTATIONS REGARDING FARES AND SERVICE FOR THE FUTURE

The four major areas which are expected to affect service and fare stability the most over the next decade are:

1. Limitations in public funding and changes in the availability of funding from various sources.

2. The continued shift in the location and density of residences and jobs within the Boston region and the resulting long-term service design.

3. The issues of operational improvements and related management rights for the MBTA.

4. Changes in the costs and supplies of fuels and other resources required for transit operations.

These factors will have a significant impact on fare policy, long-term service design, and operations, and thus will shape the future of fare levels and service provision.

These issues are discussed below:

- Public Funding and Fare Policy

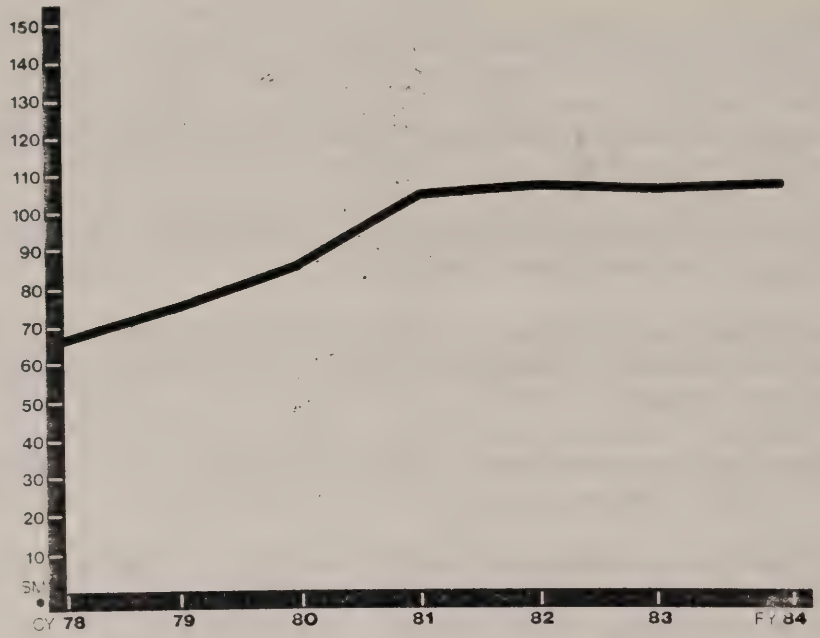
  A great deal of uncertainty exists concerning the future of federal support. Although Congress has not supported the move, current proposals at the federal level provide for the phased elimination of transit operating subsidies over the next three years. These subsidies currently provide approximately $20 million per year, which is the equivalent of approximately 9 percent of the MBTA's annual current expenses. Figure 8-1 shows the increase in State assistance and the decrease in federal funding.

  The line representing funds provided by the federal government are from the Urban Mass Transportation Administration (UMTA) and are designed to support the general operation, as opposed to the construction efforts of the MBTA. These funds help reduce the operating deficit of the Authority and therefore, help reduce the financial impact on the State, as well as on the cities and towns in the MBTA district.

  This assistance is projected at the same level for the near future as had existed in 1982. However, as stated earlier,

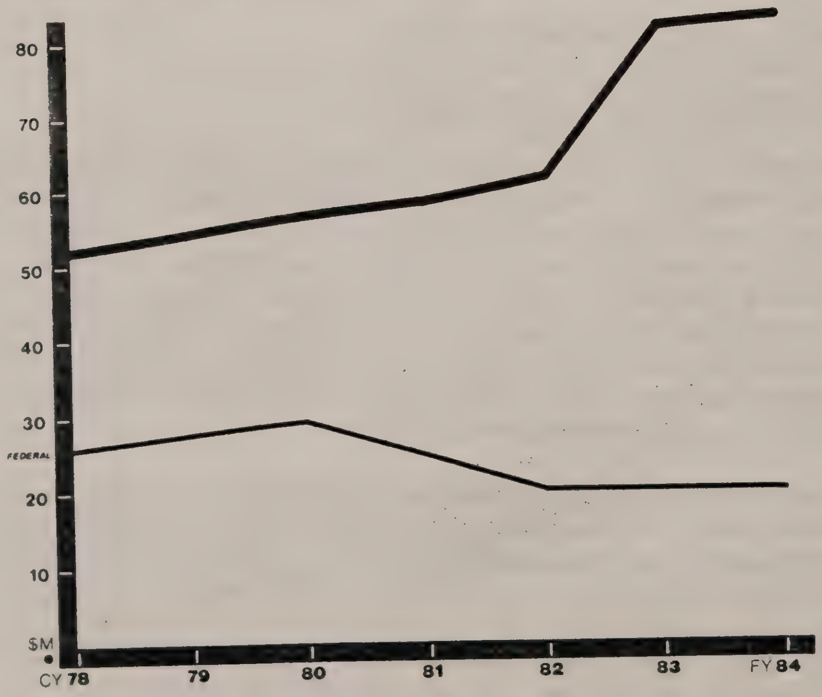
Total Income

Total income, after December of 1982, will increase 4 percent for calendar year 1983 and 6.7 percent over the next eighteen months.



State and Federal Assistance

State assistance will grow in proportion to the fixed debt of the Authority.



TRENDS IN THE MBTA BUDGET AND PROJECTED BUDGET substantial uncertainty exists concerning the future of this support. An initial proposal by the current federal administration was that these funds be eliminated by a one-third reduction each year beginning in 1981, resulting in no federal support of the operating deficit for the fourth year and thereafter.

Reimbursement is also made to the Authority by those localities which receive commuter rail service, and which are outside the 79 cities and towns which form the MBTA district. The reimbursement is provided to the outside districts by the federal government. There is substantial uncertainty concerning the future of these subsidies due to differences between the reductions proposed by federal Executive and Legislative branches. However, for 1983/FY84, the MBTA has projected a basically level funded amount.

Some increases in revenues from service are also expected to have some positive effects on the future fare picture. This income is derived from MBTA rapid transit, streetcar, and bus operations. 1982 Revenue (from transportation) had decreased to an annualized rate of approximately $88 million, caused by the reduction of fares in the spring of 1982. However, revenue from transportation is projected to increase by approximately 4.5% in 1983 and by approximately 6.7% over the 1983/FY84 period due to a projected increase in ridership.

In addition, commuter rail ridership had increased over 9% in 1982 and the Authority is projecting this trend to continue, which will enable a $200,000 reduction in this subsidy to be paid to the Boston and Maine Railroad (which is contracted to operate commuter rail services for the MBTA). However, as in the case of the MBTA, if fuel costs in the near future exceed presently projected levels, there will be insufficient funds to cover present levels of service.

Increases in ridership are being sought and appear to be headed in a positive direction and will draw additional revenue into the system. However, farebox revenue currently (1983) covers only 28% of total costs--up 7% since 1981.

Additionally, with Proposition 2½, local financial assistance is limited. Without a reversal of these policies, additional funding will need to come from other sources.

As a result, increased reliance on fare revenue as means of funding transit service can be anticipated. It is expected that as costs increase with inflation, fares will increase such that fare revenue provides for a greater percentage of total funding. However, the MBTA expects that although fare increases will occur in the future, they will occur so as to moderate fare impact on travel patterns.

In addition to increases in income, the MBTA can also greatly effect the net cost of service through reductions in operating costs and the institution of efficiency measures. These are discussed in a following section.

- Long-Term Service Design

As with operating subsidies, federal assistance for capital funding is expected to be far less in the next decade than in the 1970's. In the 1970's, a major infusion of capital funds was made to mass transit through the Interstate Transfer Provision of the Federal Highway Act. Interstate Transfer Funds available to the MBTA are fully committed to the Red Line Northwest and Orange Line Relocation projects. It is expected that remaining federal assistance for mass transit capital improvements will continue at the $70 million to $85 million a year level.

This trend in reduced capital funding is made more significant in the long-term when considering demographic trends in the region as a whole. The shift in population within the region during the 1970's contained a historically familiar pattern of heavy population outflows from the urban core to low-density communities located on the periphery. Population loss occurred in 44 communities in the region and was especially heavy in Boston, Chelsea, Everett, and Somerville. Employment location changes are most dramatic in the growth seen in the Northwestern and Southwestern communities; however, the Inner 128 subregion will gain the greatest absolute number of jobs. Appendix H provides a more detailed comparison of population and employment changes by subregion. In summary, the trends indicate that there will be shifts in transit demand in the coming decade (and beyond) which may not be matched by available resources.

To scale the MBTA's capital program to match the federal funding, the program's emphasis is expected to shift away from service expansion and toward plant rehabilitation and efficiency projects.

Currently anticipated service expansion will consist of the completion of the Red Line Northwest Extension from Harvard Square to Alewife Brook, the Orange Line Relocation -- South Cove to Forest Hills, and Quincy Adams Station. Other capital investments which will alter rail routes will not be service extension but rather will consist of service restoration of previous routes and relocation projects.

Proposed capital improvement projects are oriented toward reducing operating costs and serving dispersed travel markets. Projects include fringe parking facilities and priority treatment for surface transit vehicles. Such priority treatment would include bus lanes and preemptive traffic signals for surface rail vehicles and buses.

Additionally, with the increased dispersal of population and increased employment in an expanding regional market, emphasis on express bus and commuter rail service will likely increase, as will cross-town services around the Boston Core.

- Operational Costs and Efficiency Improvements

This area shows promise in offering some relief from decreases in general operating funds. With the management rights legislation (detailed in Appendix D), the application of some forms of modern technology, and more thorough data collection and management procedures, transit operations can become increasingly efficient. This elimination of inefficient work rules and more efficient utilization of resourses can gain significant savings which can directly reduce the need to turn to system users for increases in revenue. Major areas of improvement are:

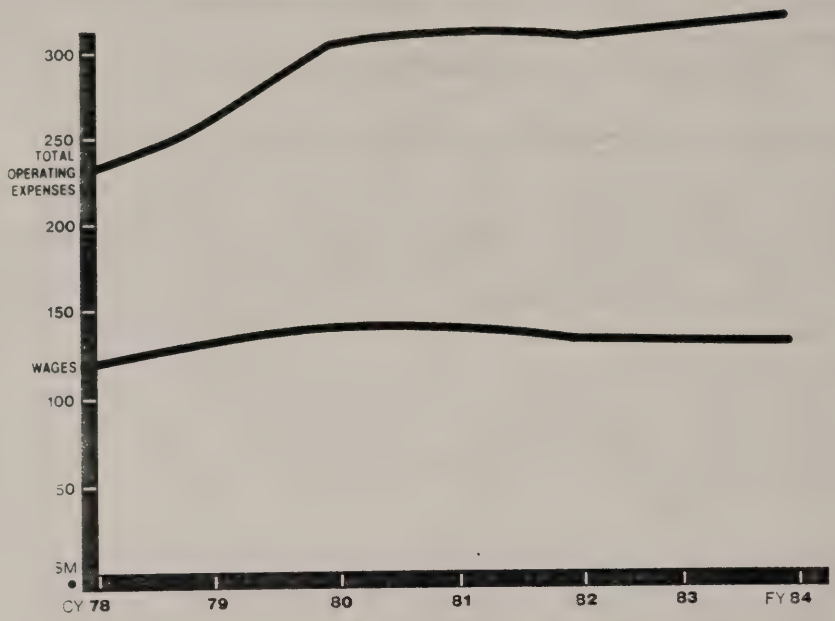
1. Work Rules - As a result of the passage of the Management Rights Act (Chapter 581 of the Acts of 1980), and its implementation on October 22, 1981, MBTA management has bee provided with the capability to operate the Authority in a manner consistent with desirable management prerogatives. The effects of this action can be seen in Figures 8-3 and 8-4. Being considered here are the salaries of all individuals working on daily operations of the MBTA. Separate from this and with its own budget is the Construction Directorate of the MBTA. This Directorate is funded by a split of approximately 80% federal support and 20% Authority bonding.

   As can be seen, wages for the Authority peaked in 1980. In 1981, the Authority dropped over 600 individuals from its payroll and over the next two years, will drop an additional 100 individuals from the 1981 level. There are no provisions for any union wage settlements projected here. Without wage increases, the wage line will decrease by approximately $1.8 million over 1983-1984. This decrease may be attributed principally to the integration of part-time workers into the Authority's work force.

   The transit industry, unlike other businesses, has peaks during mornings and evenings of each day, which mandated an available work day for many workers of 11 plus hours although they physically had to be on the property for only eight plus hours. The amount of time that operators were required to be available, but were not actually working, was paid at a "spread time" rate (10th to 11th at ½ salary, 11th plus hours at regular pay). Up to four

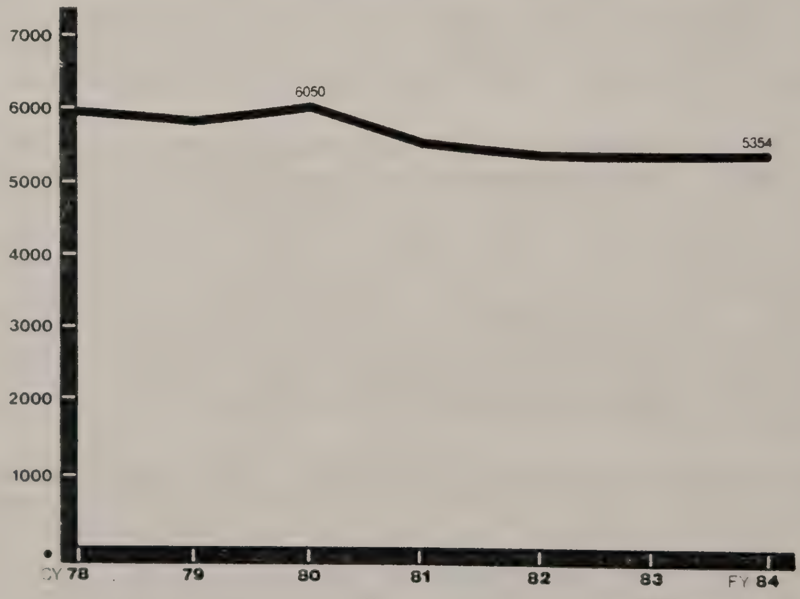
Total Operating Expenses/Wages

By the end of FY 84, wages will have decreased $9 million from 1980.



Manpower (Operating)

Manpower at the Authority, by the end of FY 84, will be approximately 700 individuals lower than 1980.



TRENDS IN THE MBTA BUDGET AND PROJECTED BUDGET

TA

8-3

hundred part-time employees now will work the peak hour traffic at approximately 70% of the present full-time rates.

This type of change in allocating the work force has both immediate results as well as continuing benefit in reducing costs or in being able to provide upgraded service for equal costs.

2. Modern Equipment - The application of new equipment to operations can result in greater efficiency. Equipment used to extract revenue from fare boxes, for example, has resulted in reduced handling of cash and associated reductions in labor and increased control over revenue collection. Increased energy efficiency can also result from newer and well maintained equipment.

3. Contracting for Services - In areas which lend themselves to contracting with private parties rather than providing services with MBTA personnel, the MBTA has been exploring the possibility of contracting. As a result, the MBTA will be able to contract for services when work can be done more efficiently than with in-house staff.

4. Management Information Systems - Management Information Systems (MIS) provide for faster flow of information to permit management to make decisions resulting in the more efficient utilization of available resources. To date, the MBTA has implemented Accounts Payable and Materials systems. The Accounts Payable system permits the MBTA to make payments on bills in a more timely manner, thereby taking advantage of discounts for early payment and improving cash flow. Also, much of the billing documentation is being generated by computer, thereby reducing labor requirements.

   The Materials system provides for greater control of intentory, thereby resulting in reductions in the percentage of out of stock items and reduced inventory size and value. The reduced inventory saves money directly and the improved availability of materials reduces delays for the material user.

   Another system in the development phase is equipment maintenance. This system will enable management to track maintenance activity by employee, by vehicle, or by vehicle components to be replaced or repaired. This information can be used to track and identify equipment design and maintenance problems, evaluate personnel performance, and further control material inventories.

- Costs of Power and Utilities

In this category, a good deal of uncertainty exists for the long-term; however, short-term values may be projected. Reasonable estimates, based on what is known today about current and projected fuel utilization, indicate a rise during the near future however, energy efficiency.has been increasing as described in Appendix F-11 in detail.

Two basic components are contained within this graph:

- Power for running the system. This line has increased due to increases in the cost of electric power and by additional power needed for the running of Rapid Transit trains (non-revenue) on the Red Line Extension, Somerville.

- Fuel for buses and other equipment. This item is projected to increase by approximately $441,000. The increase is entirely due to estimates by the Authority that fuel costs will rise by 6.4% in the near future.

	1982 Price	Projected Average
Diesel Fuel	$.92 to $1.07 per gallon	$1.04 per gallon
Unleaded Gas	$.95 to $1.13 per gallon	$1.01 per gallon
Regular Gas	$.91 to $1.09 per gallon	$ .98 per gallon

In addition, with some more modern equipment (newer buses), and experimentation with fuels and fuel additives, the Authority expects to increase its average miles per gallon on buses (presently 3.6 miles per gallon). This is included in the total future values but can mitigate some future increases.

al Environmental and Socioeconomic Impact Report
e M.B.T.A. Fare Increase

ppendices

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APPENDIX A-1

THE POLICY FRAMEWORK FOR THE MBTA AND THE REGION

I. M.B.T.A. GOALS AND POLICIES

The MBTA is a transportation operating agency. As such, its primary concern is to increase ridership while minimizing rises in costs. The following goals, stated in the 1977 Program for Mass Transportation of the MBTA, provide the MBTA management with both overall directional goals and some specific objectives which indicate the achievement of these goals.

MANAGEMENT GOALS:

- Increased Riders. To attract additional riders who can be served at reasonable cost in relation to present costs per rider.

- Control of Overall Financial Burden. To bring under control the overall costs of supplying public transportation and to seek an equitable distribution of the resultant financial burden among riders and public revenue sources.

- Improved Quality of Service. To improve the quality of service offered, where this is possible without unreasonable increases in costs per rider.

- Unit Costs and Productivity Improvement. To reduce the cost of supplying a desirable level of public transportation service and to increase the level of service provided at a given expenditure level.

- Improved Safety and Security. To reduce the hazards to which riders and employees are exposed in connection with public transportation service.

- Equitable Fares and Service. To implement a fare structure and fare level which are equitable in terms of price per value received and to apply uniform criteria for the establishment and discontinuation of service.

SOCIAL GOALS:

The MBTA is also an agency of government. Consequently, it must serve the public in an environment shaped by society's demands as expressed through its elected officials. It should be responsive to at least the following social goals:

- Provision for Riders with Special Needs. To provide transportation service for the elderly and handicapped persons, particularly those who do not have ready access to an automobile.

- Environmental Improvement and Fuel Consumption. To reduce air pollution, noise pollution, other forms of environmental degradation, and fuel consumption associated with supplying public transportation service.

- Equal Opportunity/Affirmative Action. To remedy the effects of any illegal discriminatory practices in the MBTA, to eliminate such practices, and to take positive action so that the MBTA work force reflects the racial and sexual composition of the population where the jobs exist.

- Economic Recovery. To contribute to the reduction of the unemployment rate in Massachusetts and stimulate the depressed economy through a large scale capital investment program.

- Land Use and Development. To contribute to and facilitate the process of land use planning and development for the long term.

Furthermore, the 1977 PMT directly discusses the costs which some goals may entail:

> "It is important to recognize that achievement of social goals may impose costs on the MBTA which are in excess of those associated with a strictly operating efficiency criterion. Investment of resources for social purposes produces returns, but not ones as easily identified as more riders or lower costs. Therefore, a dilemma facing the MBTA and the public will be how to share more equitably the burden of MBTA cost. Within the MBTA's control is the ability to achieve greater efficiency in both operations and construction, in order to stabilize the relationship between fare revenues and operating costs. Yet to be resolved is how the public will choose to share in the increasing costs of the MBTA as a means for achieving social goals."

Although the policies in the PMT are directed principally to guide the MBTA capital program, it states clearly that many of its specific objectives and policies under each of the overall management goals will be attained primarily through actions outside of the capital program. Below is a discussion of several of the areas of concern which are most relevant to the issue of fare increases, ridership, and revenue balancing:

1. Increased Riders

Public Transportation Service Policy. The most far reaching of the service goals stated in the MBTA's Service Policy for Surface Public Transportation, adopted by the Board of Directors on January 7, 1976, was:

> "To achieve an annual system passenger volume of 200 million riders by 1981 with approximately the same or fewer employees."

Although this specific goal has not yet been met, its statement implies that the MBTA should attract such an increase by providing better service and that it should be able to accommodate the increase when it materializes. At the same time, it must increase productivity by producing more service with the same number of employees.

2. Control of Overall Financial Responsibility

The MBTA is one of the highest cost operators of public transportation in the United States. In addition, fare revenues cover only about 30 percent of operating expenses, not counting debt service. If debt service is counted, the figure is closer to 25 percent. If the only major management goal were the reduction of losses, then a logical policy would be not only to stop building extensions of rapid transit service, but also to contract drastically existing service and to raise fare levels accordingly--with profound effects on the capital program. However, this is clearly not a viable policy, since there are other management goals, as well as public policy goals outside the context of MBTA management, that should be pursued, not the least of which is stimulating the regional and state economy.

MBTA management sees its responsibility rather as bringing under control the overall costs of supplying public transportation and seeking an equitable distribution of the financial burden among riders and tax sources. This will be accomplished by a variety of means.

A final policy relating to the goal of controlling and equitably distributing the financial burden is that of maximizing revenue obtainable from rentable or leasable property incidental to providing public transportation. With regard to the capital program, this means that MBTA will take advantage of opportunities for joint development in conjunction with new rapid transit stations or station modernization work. Where it is both profitable to the MBTA and convenient to passengers; where it does not impede transportation operations or passenger flow; where it is consistent with good design and land use practice; and where it is consistent with guidelines of the Federal government for use of grant funds, the MBTA will include space and/or other features in its design of stations or other facilities that can accommodate appropriate joint development.

3. Unit Costs and Productivity Improvement

Maintenance Policy. The MBTA recognizes that considerable improvement is needed in the general condition of its existing plant and vehicle fleet and in the cost of maintaining these in serviceable condition. This is not a problem that can be solved by setting idealized standards for this condition or by simply devoting more resources to the maintenance function. It is rather a problem of increasing the output for a given level of maintenance resources and of organizing the work so that this improvement actually takes place. The MBTA has the following objectives aimed at improving maintenance output:

- Train the work force and improve the quality of management toward maintaining existing equipment and the new equipment now on order in a systematic way.
- Develop better information systems to detect problems needing maintenance attention and to forecast workloads.
- Set reasonable goals for the gradual improvement of specific service conditions that depend on maintenance, such as number of cars available for service.
- Assure that major new investments do not in themselves lead to maintenance problems.
- Tighten up on spare vehicles in order to reduce the tendency to rely on spares as an alternative to preventive maintenance practices.
- Provide modern diagnostic and repair equipment.
- Provide modern facilities to house the maintenance operation.

4. Equitable Fares and Service

A fare system based on distance and quality of service is probably the most equitable in the long run for the MBTA region, particularly when additional rapid transit extensions are completed. It is also the most difficult to implement in a logistical sense and would require more sophisticated forms of fare collection equipment. Automatic fare collection equipment is now a part of the capital program, but should a decision be made to implement a significantly more complicated fare system, fare collection equipment adequate for that purpose would have to be included. Such a fare structure may also affect indirectly the capital program, since it could result in a shift of passengers from one mode of public transportation to another and, consequently, some shift in emphasis in capital investment.

The Authority has studied the ridership and revenue impacts of restructuring the fare system. Major readjustments of this system would call for increase of fares on some portions of the system.

The Surface Transportation Service Policy provides for an objective mechanism for making changes in public transportation service on the basis of riders, costs, and social factors. This would then indirectly affect the capital program in terms of any changes in the surface fleet requirements that could emerge from restructuring surface routes and service frequencies.

5. Environmental Improvement and Fuel Consumption

Air Pollution and Fuel Consumption Policy. It is not possible to make a general recommendation for the promotion of one transit mode over another on the basis of air quality considerations alone. This is because no transit mode has the lowest pollutants per vehicle mile in all categories of emissions. At the same time, transit modes are almost always superior to the private automobile. Therefore, a general policy of promoting mass transportation is beneficial with respect to air quality.

Pollution characteristics of the public transportation modes are closely related to energy consumption. An improvement in energy efficiency will generally lead to less pollution. The levels of energy consumption for transit submodes at the MBTA differ greatly from typical levels for transit in the United States. This is particularly true for rapid transit, where the data seem to indicate that the present power generation and delivery system is grossly inefficient in terms of fuel per car mile, in relation to a typical rapid transit operation.

It is the MBTA's policy to reduce the pollution generation characteristics of its system by renewal and replacement of its existing power distribution system and of its buses, trolleys, and diesel rail engines. It is the MBTA's policy to improve pollution abatement at its existing power source, to reduce energy consumption and pollution levels by switching to a more efficient, privately supplied source of electric power, and by reducing as much as possible pollution/energy intensive practices, such as running bus engines overnight. Federal requirements for planning certification and for capital assistance also provide assurance that air quality is considered in MBTA planning and management.

Noise Policy. The MBTA takes all reasonable design measures to reduce noise effects, particularly in areas adjacent to residential areas in areas of high employment density. All reasonable measures are taken to design vehicles and stations to reduce noise effects.

II. RELEVANT POLICIES OF THE BOSTON REGIONAL TRANSPORTATION SYSTEM

The MBTA is an integral part of the regional transportation system and, as such, it shares the transportation-related goals and objectives of the region. These goals and objectives are agreed upon by the agencies which compose the Metropolitan Planning Organization and are supported by a policy framework.

The bulk of policies expressed in the Regional Transportation Policy Framework is oriented towards the capital improvement program. These are not included here. Rather, the following is an edited version which includes only the portions relevant to the MBTA and its Service and Fare Policy. The entire regional policy may be found in the current Transportation Plan for the Boston Region.

The preeminent stated goal of the transportation planning program for the Boston region is to improve the region's transportation facilities and services in a manner which enhances the quality of life for the people who live, work, and travel here--now and in the future.

1. Costs in Operating the Transportation System

The policy for cost control focuses on the reduction of costs and the implementation of projects, which reduce operating requirements. In part, the policy states:

> "Through increasing the productivity of the public transportation system operations and improving construction and maintenance techniques for the transportation system as a whole, the costs of operating the system can be controlled."

REGIONAL GOAL ON COST:

Make optimum use of existing facilities and, thus, wherever possible, incur a minimum of capital outlays.

REGIONAL OBJECTIVES ON COST:

A. Undertake careful analysis of all projects, including low-cost alternatives.

B. Emphasize projects which increase the use and capacity of existing facilities.

C. Improve the efficiency of the existing transportation system, so that maximum benefits are derived at reasonable cost to the public.

2. Equity and Accessibility

The transportation system must serve all of the people of the region, without systematic bias based on geographic location, income, race, or physical disability. In particular, special efforts are necessary to ensure that the system addresses the needs of the elderly and handicapped. The system must strive to provide a real choice of transportation modes to all segments of society.

GOAL:

Transportation systems should be designed to equitably service and reinforce the social and economic vitality of the region's communities. In addition, special emphasis should be placed on meeting the transportation requirements of those with special needs (e.g., the elderly, the disabled, economically deprived, etc.).

OBJECTIVES:

A. Increase Accessibility to Populations with Special Needs. An objective of the transportation plan is to make the transit system more accessible to persons with physical disabilities, where economically and technologically possible; otherwise, to provide for specially-designed service.

B. Increase Sensitivity to Needs of Minorities and Low-Income Groups. Future design and planning of facilities should be particularly sensitive to the special needs of minority and low-income groups. These people are particularly affected by the high cost of travel by private automobile, which severely inhibits their participation in the job market and other economic spheres.

3. Energy

The transportation program needs to ensure that conservation and the efficient utilization of energy resources occur in both the operation of facilities and the development of new infrastructure.

Because fossil fuels are becoming a scarce and, therefore, costly resource, the plan should emphasize actions that decrease fuel consumption per trip (for example, by increasing auto-occupancy rates and by increasing transit usage and the number of passengers per transit vehicle). Ideally, a reduction in fuel consumption will not affect the total number of trips in the region.

GOAL:

To coordinate and encourage an energy-conserving transportation syste, which offers modal choice while maintaining efficiency.

REGIONAL OBJECTIVES ON ENERGY:

A. Support improvements in transportation that conserve energy.

B. Continue to develop transit as an energy-efficient form of transportation.

C. Emphasize strategies and actions that decrease fuel consumption per trip.

D. Encourage fuel conservation by transit vehicles and fixed facilities through revised design and maintenance.

4. Environmental Quality

Transportation facilities must be compatible with the environment of the region. In addition, the transportation plan must include measures to reduce air, noise, and water pollution.

GOAL:

To attain and maintain the highest possible level of environmenta quality for the region.

REGIONAL OBJECTIVES ON ENVIRONMENTAL QUALITY:

A. Reduce Vehicle Miles of Travel (VMT). Program elements should be developed to reduce VMT regionwide by drawing automobile users to the transit system. Reduction in VMT will lead to air quality improvements, reduced land requirements of highways and parking facilities, and other environmental benefits.

B. Improve Areas Along Transit Routes. Areas near transit route can be greatly improved by the elimination of elevated structures in developed residential areas, reducing street congestion caused by transit vehicles, and by minimizing negative local impacts of new transit construction.

In conclusion, the basic policy framework for transportation planning in the region is to seek an improved transportation system that is environmentally compatible, socially equitable, energy conscious, cost efficient, and related to regional land us and economic development goals.

APPENDIX A-2

THE MBTA BUDGET* 1978-1982 AND AN EXPLANATION OF NET COST OF SERVICE

The Authority monitors its daily financial activities by accumulating costs within the line items. The line items shown on the statement of Net Cost of Service, 1978-1982 represent the sum of the Authority's expenditures. For control purposes, these same line items can be tracked to each of the Authority's organizational units.

1. Revenue from Transportation

   This is the income derived from MBTA rapid transit, streetcar, and bus operations. 1982 Revenue from Transportation has decreased to an annualized rate of approximately $88 million, caused by the reduction of fares in the spring of 1982. Revenue from Transportation is projected to increase (by approximately 4.5%) in 1983 due to a projected increase in ridership.

2. Revenue from Other Railway Operations

   This line represents income derived from the rental of fixed assets owned by the Authority and from advertising on Authority property.

3. Non-Operating Income

   This is income which results from the investment of cash and Bond Issue proceeds. This income will decrease in the future because the State has altered its method of advancing cash to the MBTA, now advancing smaller amounts over shorter periods of time. In addition, in an effort to soften the impact of the fixed charges on the Authority's budget, the Bond Issues needed to support the cash needs of the MBTA's construction programs are also planned to be made in smaller amounts for shorter periods of time.

4. Gasoline and Diesel Tax Reimbursable

   This line represents reimbursement by the State to the MBTA of the State gas and diesel taxes which the Authority must pay to vendors for its fuel purchases.

5. Reimbursement from Outside Districts

   This is the reimbursement made to the Authority by those localities which receive commuter rail service, and which are

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*Not including Capital Expenditures Budget.

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY
NET COST OF SERVICE

	1978 Actual	1979 Actual	1980 Actual	1981 Actual	1982 Projected	1st 6 Months 1983	Calendar 1983	Fiscal 1984
Income:								
1 Revenue from Transportation	$ 55,196,145	$ 56,727,494	$ 66,197,081	$ 81,811,655	$ 91,251,611	$ 46,070,000	$ 92,140,000	$ 93,952,800
2 Revenue from Other Railway Operations	2,103,421	2,263,665	2,650,449	3,101,327	3,300,001	1,788,217	3,576,434	4,094,534
3 Non-Operating Income	8,099,828	13,650,718	13,622,874	17,227,923	9,129,487	3,397,000	5,723,000	5,349,000
4 Gas & Diesel Tax Reimbursable	409,183	431,431	478,847	517,631	541,200	270,000	541,200	541,200
5 Reimbursement from Outside District	1,861,462	1,968,721	3,385,982	1,509,560	1,300,000	600,000	1,200,000	1,200,000
TOTAL INCOME	67,670,039	75,042,029	86,335,233	104,168,096	105,522,299	52,125,217	103,180,634	105,137,534
Operating Wages and Fringe Benefits:								
6 Wages	121,425,859	129,721,199	140,574,029	137,873,214	134,569,175	67,081,767	133,347,403	132,765,451
7 Gen. & Adm. Cost Capitalized-Credit	-	-	-	(2,060,840)	(2,007,783)	(776,785)	(1,553,570)	(1,553,570)
8 M.B.T.A. Pensions	16,725,658	18,830,410	21,349,749	20,285,101	18,968,153	9,876,450	19,633,631	19,402,444
9 Social Security Taxes	6,712,769	8,409,994	9,592,495	10,383,167	10,267,695	5,129,307	10,297,606	10,258,615
10 Workmen's Compensation	1,812,198	2,812,368	3,441,116	3,281,399	3,752,876	2,814,192	3,752,876	3,752,876
11 Accident and Sickness Insurance	407,533	431,677	438,416	427,971	364,162	180,816	361,632	361,632
12 Group Life Insurance	688,547	670,677	694,013	909,421	888,405	454,788	909,576	909,576
13 Blue Cross - Blue Shield	12,685,570	13,590,031	14,403,366	16,403,968	17,374,473	9,924,684	19,849,368	21,654,577
14 Unemployment Insurance	52,350	267,363	178,800	786,430	400,000	200,000	400,000	400,000
15 Uniform and Work Clothes	414,089	541,660	587,473	532,615	532,524	350,375	627,773	627,773
16 Fringe Benefits Cost Capitalized - Credit	(3,408,571)	(5,753,121)	(7,588,894)	(7,482,213)	(7,499,746)	(3,755,135)	(7,510,270)	(7,510,270)
TOTAL OPERATING WAGES & FRINGE BENEFITS	157,516,002	169,522,258	183,670,563	181,340,233	177,609,934	91,480,459	180,116,025	181,069,104
17 Material and Other Items	21,622,746	24,755,273	30,783,586	30,992,979	33,007,830	19,439,086	37,957,063	41,027,074
18 Injuries and Damages	2,099,955	2,517,339	2,666,762	2,940,880	2,884,881	1,692,440	3,384,880	3,384,880
19 Unreimbursed Cost of Service	-	(2,800,000)	2,800,000	-	-	-	-	-
20 Interest on Unfunded Debt	7,280,540	11,795,984	16,553,721	22,868,808	21,611,565	9,506,250	19,012,500	19,012,500
21 Fuel	12,261,738	16,208,764	22,265,512	23,239,837	22,343,472	11,600,619	23,341,339	23,635,439
22 Taxes (Other than Included above)	792,861	864,974	881,531	1,008,541	990,852	495,411	990,822	990,822
23 Railroad Commuter Subsidy	31,033,826	37,997,194	44,870,592	47,096,950	46,196,373	22,998,186	45,996,373	45,996,373
24 Local Service Subsidies	895,317	1,112,288	1,517,912	1,511,200	1,613,184	1,100,414	2,074,721	2,074,721
TOTAL OPERATING EXPENSES AND TAXES	233,502,985	261,974,074	306,010,179	310,999,428	306,258,091	158,312,865	312,873,723	317,190,913
Fixed Charges:								
25 Interest on Funded Debt (M.T.A.)	3,774,469	3,686,265	3,423,192	3,637,624	4,144,824	2,704,484	5,408,968	5,408,968
26 Interest on Funded Debt (M.B.T.A.)	16,904,784	19,235,046	20,047,186	20,891,292	31,456,901	20,413,739	44,525,895	46,924,313
27 Payment on Funded Debt (M.T.A.)	2,999,259	2,824,259	2,723,259	2,537,259	2,631,926	1,801,352	3,602,704	3,602,704
28 Payment on Funded Debt (M.B.T.A.)	9,326,748	9,331,173	10,710,000	10,685,000	12,829,250	8,507,500	17,015,000	19,995,000
29 Bond Discount Amortization (M.B.T.A.)	-	-	-	21,150	84,600	-	-	-
30 Miscellaneous Debits (M.T.A.)	46,879	35,838	56,000	45,989	-	-	-	-
31 Bank Service Charges (M.B.T.A.)	35,112	49,752	24,000	23,870	101,500	75,000	150,000	150,000
TOTAL FIXED CHARGES	33,087,251	35,162,333	36,983,637	37,842,184	51,249,001	33,502,075	70,702,567	76,080,985
TOTAL CURRENT EXPENSES	266,590,236	297,136,407	342,993,816	348,841,612	357,507,092	191,814,940	383,576,290	393,271,898
COST OF SERVICE IN EXCESS OF INCOME	198,920,197	222,094,378	256,658,583	244,673,516	251,984,793	139,689,723	280,395,656	288,134,364
32 State Fin. Contract Assist. - M.T.A.	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	1,500,000	3,000,000	3,000,000
33 State Fin. Contract Assist. - M.B.T.A.	21,696,562	23,840,018	26,524,496	29,906,496	39,161,667	27,914,214	59,170,414	62,291,836
34 Federal Operating Assistance	26,628,398	27,422,397	29,328,419	26,236,287	20,281,265	10,140,633	20,281,265	20,281,265
35 NET COST OF SERVICE — LOSS	$147,595,237	$167,831,963	$197,805,668	$185,530,733	$189,541,861	$100,134,876	$197,943,977	$202,561,263

outside the 79 cities and towns which form the MBTA district. The reimbursement is provided to the outside districts by the federal government. There is substantial uncertainty concerning the future of these subsidies due to differences between the reductions proposed by federal Executive and Legislative branches.

6. Wages

This line contains the salaries of all individuals working on daily operations of the MBTA. Separate from this line and with its own budget (not included within this document) is the Construction Directorate of the MBTA. This Directorate is funded by a split of approximately 80% federal support and 20% Authority bonding.

As can be seen from the Net Cost of Service statement, wages for the Authority peaked in 1980. In 1981, the Authority dropped over 600 individuals from its payroll and over the next two years, will drop an additional 100 individuals from the 1981 level.

The transit industry, unlike other businesses, has peaks during mornings and evenings of each day, which mandated an available work day for many workers of 11 plus hours although they physically had to be on the property for only eight plus hours. The amount of time that operators were required to be available, but were not actually working, was paid at a "spread time" rate (10th to 11th at ½ salary, 11th plus hours at regular pay).

In analyzing the wage line from the Net Cost of Service, it should be noted that the Authority, in 1981, began to show the dollars charged by operating personnel to capital construction on a separate line, "General & Administration Cost Capitalized-Credit." Prior to 1981, these dollars were directly deducted from the wage line. Therefore, the Authority, in 1981, reduced its wage line not by $2,700,815 but by $4,761,655.

7. General and Administrative Cost Capitalized - Credit

This line is an accounting adjustment. It credits operating expenses for indirect overhead charges and material handling expenses which can be charged to the Construction Directorate. The percentage basis for the credit is approved and audited by the Urban Mass Transportation Administration, which is contributing approximately 80% of the cost of the Construction Directorate.

8. MBTA Pensions

This line is calculated based on an Authority contribution to the employee pension fund of 12.1875% of wages. In addition to the Authority contribution, employees contribute 8.0625% of their salaries. The pension play is based upon a normal retirement age of 65 (the mandatory retirement age has been increased to 70). An early retirement is available, regardless of age, based upon 23 years of creditable service. An early reduced retirement is available based on 20 years of creditable service at age 55, but the computed retirement allowance is reduced by one-half percent for each month the member is under 65. The plan also provides for occupational and non-occupational disability retirement after four years and eight years of creditable service, respectively.

9. Social Security Taxes

All employees at the Authority are covered by social security. The present employer contribution is 6.7% of salary for the first $32,400.

10. Workmen's Compensation

The MBTA, as an employer in the Commonwealth, is required to provide Workmen's Compensation coverage pursuant to Chapter 152 of the Massachusetts General Laws. The Authority, in accordance with Section 25A of Chapter 152, has elected to be a self-insurer for the purpose of providing compensation to employees injured or disabled in the course of their employment. As a self-insurer, the Authority must furnish the Treasurer of the Commonwealth with a bond sufficient to meet the insurer's liability. In addition to this bond, the Authority must establish a re-insurance program to fund liabilities for catastrophic loss.

11. Accident and Sickness Insurance

The Authority provides its employees with $2,500 accidental death and dismemberment coverage and 26 weeks of coverage for accident and sickness. The death and dismemberment policy costs $.20 per employee per month and the health and accident $5.31 per employee per month.

12. Group Life Insurance

The Authority provides $9,000 of life insurance coverage to weekly employees at a cost of approximately $10,80 per employee per month, which is reduced to $2,000 of coverage at approximately $2.40 per month at retirement. New weekly employees have a one-year waiting period for coverage. Monthly and executive employees receive $9,000 paid life insurance at approximately $10.80 per month, and may choose to take up to one and one-half times their salary in additional life insurance coverage. The Authority will pay half of the premium above the $9,000 basic coverage. At retirement, the basic coverage is reduced to $2,000 paid 100% by the Authority. Anything over that is shared on a 50% basis up to one-half the amount of the before-retirement salary.

13. Blue Cross/Blue Shield

The Authority provides paid medical coverage to all its employees under age 65 (retired individuals under age 65 who retired after January 1, 1954 are also covered). On January 1, 1982, the Authority switched from a premium basis to a cost basis for all current employees (except for dental coverage which remains on premium and is shared 50% by employees). The savings during 1982 resulting from the changeover was approximately $3.5 million. Even with savings realized because of the change to cost basis payments, the Authority will still have to meet the increases which are occurring in the medical field.

14. Unemployment Insurance

During 1982, two different groups of layoffs caused a rise in Authority Unemployment payments:

a. In approving the 1981 budget, the Advisory Board imposed financial ceilings on the Authority causing operations cutbacks that necessitated the layoffs of large numbers of employees.

b. The Authority laid off 68 rapid transit train guards which, while reducing wage costs by $2 million increased unemployment contributions.

15. Uniforms and Work Clothes

This line contains the dollars for two types of clothing:

- Uniforms. Operational personnel, coming in contact with the general public, are provided "T" uniforms. Transportation worker uniforms are priced at $314 for initial issues and Police at $500 for initial issues.

- Work Clothes and Safety Apparel. The Authority, by union contract and to meet the requirements of the Occupational Safety & Health Administration, provides its shop workers with work clothes and safety apparel. Work clothes are budgeted at approximately $84 per worker per year, and safety items such as gloves, acid clothing and eye protection are priced in groupings by historical usage.

16. Fringe Benefits Cost Capitalized - Credit

This line is an accounting adjustment which credits operating expenses for pension, vacation, holiday, sick pay, insurance and other benefits which are incurred by individuals charging work effort to the Construction Directorate.

17. Material and Other Items

This line item contains the costs for the following:

- Materials. The Authority is responsible for maintaining a large variety of vehicles and equipment, rail lines and buildings. Past experience has provided data that enables the Authority to calculate, based on transportation schedules, how much repair work of what type will be required in the course of a year. For example, 450 bus transmissions are rebuilt per year; 145 bus motors are rebuilt per year; 31,600 feet of rail are replaced; 5,000 rail ties are projected for replacement. The Authority in 1983/FY84 has level funded its Material request except for parts on buses which are no longer on warranty, repair of bodies on Green Line cars, replacement of batteries on Red Line cars, and parts for Orange Line cars which are no longer on warranty. The Authority is planning on absorbing any inflationary increases through better inventory control, more efficient planning of parts utilization and less use of original equipment manufacturers' parts.

- Services. The Authority has contracts for parts rebuilding, station cleaning, bus cleaning, escalator repair, watchman services and various other functions which it has determined can be more efficiently or effectively accomplished by outside sources.

- Rent. The Authority lease at 50 High Street, Boston, for approximately 46,000 sq. ft. of administrative space expired July 1982. Current proposals from Meredith and Grew (the landlord) establish the new cost for a tenancy at will at approximately $13 per sq. foot for the majority of its space, or approximately 144 percent of the prior lease.

- Utilities. This line contains the cost of telephone service; gas, steam, oil and electricity for heating, lighting, and power; and water and sewer services.

18. Injuries and Damages

The Authority has approximately 8,000 outstanding claims and court suits against it for injuries and damages. During an

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18. Injuries and Damages

The Authority has approximately 8,000 outstanding claims and court suits against it for injuries and damages. During an average year, approximately 5,200 claims are processed and settled and the balance is carried forward. (In addition to the $1 million and rail injuries up to $2.1 million per accident or occurrence.)

19. Unreimbursed Cost of Service

This line represents commuter rail costs which were deferred from one year to the next (1979 to 1980) pending Advisory Board approval of the expense.

20. Interest on Unfunded Debt

The Authority, as does any company, requires working cash to meet its daily operating expenses. This line contains the interest charges on $195 million in outstanding notes which are renewed on a yearly basis and which partially meet the cash needs of the Authority.

21. Fuel

Two basic components are contained within this line.

- Power for running the system.
- Fuel for buses and other equipment.

	1982 Price
Diesel Fuel:	$.95 to $1.07 per gallon
Unleaded Gas:	$.95 to $1.13 per gallon
Regular Gas:	$.91 to $1.09 per gallon

22. Taxes

This line accounts for the fuel tax payments made by the Authority to the Commonwealth, those payments being based upon both volume and price per gallon. Also covered within this line are license fees for operators, and tolls on the Mass. Turnpike, tunnels and the Tobin Bridge.

23. Railroad Commuter Subsidy

This line contains the contract for the Boston and Maine Railroad to operate the commuter rail services for the MBTA. Commuter Rail ridership increased over 9% in 1982 and the Authority is projecting this trend to continue.

24. Local Service Subsidy

This line is comprised of two elements.

a. THE RIDE. This program is the MBTA's specialized paratransit service for handicapped persons. It exists in

27. Payment on Funded Debt (MTA)

This line reflects the principal payments for the BMD Bond Issues described in #25 above.

28. Payment of Funded Debt (MBTA)

This line represents the principal payments for the Bond Issues described in #26 above. Part of the increase in these payments is due to a reduction in maturity from 40 years for the original issues to 20-25 years for current issues (in the current Bond market there is no demand for Bonds with greater than 20-25 years maturity). The remainder of the increase is due to the increased capital needs of the Authority's construction program.

29. Bond Discount Amortization (MBTA)

In 1981, this amortization charge represented the difference between the principal repayment and the amount actually received after discount for Bond Issues. The initial method of handling a discount Bond was to list the payment and amortization as separate charges. Subsequently, for budget purposes, amortization has not been included as a separate line item because it is an accounting function whereas repayment is a cash requirement.

30. Miscellaneous Debits (MBTA)

This line represents the fiscal agent's charges for paying the BMD Bond coupons, as well as paying the Bonds themselves as they mature.

31. Bank Service Charges (MBTA)

These charges represent the fiscal agent's charges for paying the Authority's Construction Bond coupons, as well as the principal on these Bonds as they mature.

32. State Financial Contract Assistance (MTA)

This line represents the State's contribution to the Authority's payment of the BMD debt. The State has limited this payment to a maximum okf $3 million per calendar year for the principal and interest charges on the BMD Bonds (see #25 above).

33. State Financial Contract Assistance (MBTA)

This line represents the State's contributions of 90 percent of the principal and interest payments of the Authority's MBTA Bonds (see #26 above).

response both to a need expressed by the handicapped community and to certain federal regulations, principal among these being Section 504 of the Rehabilitation Act of 1973, as amended. Subsequent to the initial requirements provided by the regulation, the Authority has made efforts beyong those required by statute.

b. Subsidies to Local Bus Services. The primary motivation of the Authority in subsidizing bus services is to maximize service levels for the lowest cost. The Authority is currently involved in two such relationships. In both instances, the Authority underwrites the net loss of services.

In both cases subsidized by the Authority, a private carrier provided fixed route local services at a loss and appealed to the Authority for financial assistance.

Rapid Transit, Inc. has provided service in Winthrop feeding Orient Heights Station as well as meeting local transportation needs since 1942. In 1968, the Authority entered into a relationship which has continued uninterrupted. In 1981, this system provided 1.2 million rides for a net cost of $450,000.

Michaud Bus Lines, as the local carrier in Salem and Peabody, has provided local service since 1954. In May of 1977, the company gave notice they could no longer continue to incur an operating loss on the so-called "Salem-Peabody Loop." In January of 1978, the Authority began a subsidy arrangement with Michaud Bus Lines which continues today. In 1981, this system provided 150,000 rides for a net cost of $85,000.

25. Interest on Funded Debt (MTA)

This line reflects the interest charges on Boston Metropolitan District (BMD) Bonds which are currently outstanding, as well as those BMD Bonds which have matured and are planned to be refinanced in December, 1982.

BMD Bonds are those bonds issued prior to 1964 to support the Boston Metropolitan District, which was one of the transit systems which formed the MBTA. Upon its formation in 1964, the MBTA was made responsible for the debts of its transit systems. There is approximately $87,132,000 in outstanding BMD debt.

26. Interest of Funded Debt (MBTA)

This line represents interest payments on bonds which are issued to support approximately 20 percent of the Authority's Capital Construction Program (the other 80 percent is federally funded).

34. Federal Operating Assistance

This line represents funds which are provided by the federal Urban Mass Transportation Administration (UMTA) to support the general operation, as opposed to the construction efforts of the MBTA. These funds help reduce the operating deficit of the Authority and therefore, help reduce the financial impact on the State, as well as on the cities and towns in the MBTA district.

35. Net Cost of Service - Loss

This line is the net deficit after the application of the various assistance provided to offset the MBTA's operating deficit. That assistance is described in #'s 32-34 above. The net deficit amount is shared by the State and the cities and towns in the MBTA district. The portion paid by the cities and towns was capped at $95 million for calendar year 1981.

APPENDIX A-3

SCOPE FOR MBTA FARE STUDY: ENVIRONMENTAL IMPACT REPORT AND SOCIOECONOMIC IMPACT REPORT

Following are the proposed work scope outlines of the Environmental Impact Report (EIR) and the Socioeconomic Impact Report (SEIR) for the MBTA Systemwide Fare Increase, dated October 30, 1981.

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, Massachusetts 02202

ARD J. KING
OVERNOR
A. BEWICK
ECRETARY

ROJECT NAME:	System Wide Fare Increase
ROJECT LOCATION:	Statewide
EA NUMBER:	4147
ROJECT PROPONENT:	MBTA
TE NOTICED IN MONITOR:	July 7, 1981

SCOPE FOR GENERIC EIR

This scope and alternative for the MBTA System-wide Fare Increase (EOEA 04147) pplements the outline scope provided in the Certificate of the Secretary, ted July 31, 1981.

Base Case and 1980, 1981 Increases

1. Description of existing system.

This section should succinctly summarize the main components of the MBTA system, sufficient to acquaint the public reviewer (who may only be familiar with discrete components of the system) with its broad outlines and inter-relationships. Rapid transit rolling stock, commuter rail operations, railbed, buses, routes, yards and garages, commuter parking lots, extensions under construction, and key intermodal transfer points should be identified and located on maps with enough clarity to convey an overall understanding of the outlines of the system.

2. Brief summary of funding sources and breakdown, and of budgetary process (describe distribution of increase in farebox revenues).

3. Review of past fare structures and levels, and describe 1980 and 1981 fare increases. Plot fares against fuel cost, overall inflation. Show (charts

or graphs) 1970-1981 budget levels, ridership levels, and percentage paid by different funding sources.

Compare average T-fares to cost of living index; compare to other cities (cost) cost/mile - if possible include 1960, 1970 and current figures.) Compare with automobile operating costs.

4. Describe service cuts and restorations, 1979 to date.

5. Analytic methods.

   a. Describe data available to the T to determine actual ridership (including different modes, and different categories of riders).

   b. Describe alternate ways of calculating or estimating ridership (modes, categories).

   c. Describe efforts under way to improve data base, and any future changes considered.

6. Ridership, 1950-1980

   a. Provide historical ridership figures, broken down at least into rapid transit, rail, express and local bus. Provide ridership percentage in geographic parts of system (e.g., (i) downtown core (peak, off-peak), (ii) crosstown, core to 6 mile radius (peak, off-peak), 6 mile radius to 128, outside 128). Where needed for SIR* input, disaggregate by line or route. Discuss transit load factors (peak hour and daily); number of riders per rapid transit car, railcar and bus.

7. Operating trends.

   a. Comparison of peak hour quality of service (average speeds, passengers moved per hour) with off-peak performance, and with theoretical operating capacity of a system operating efficiently and according to safety requirements.

   b. Trend in revenue/operating costs ratio; costs/passenger; cost/mile

   c. Trend in capital costs per passenger mile (rapid transit, bus)

   d. Calculated energy efficiency trends: revenue car-miles per unit of input energy; rail and bus passenger-MPG.

8. Summarize status and recommendations of other public/private studies, task forces, committees to improve the MBTA (1970-1981).

. Prediction and Measurement of Ridership Losses Due to 1980,1981 Fare Increases

1. Discuss trip elasticities.

Describe methods of analysis. (If both arc elasticities and simple elasticities are used in the EIR, avoid commingling them.)

2. a) Predicted and (b) measured effects on ridership of 1980 fare increa (show calculations; break down into ridership profile. Review displacemen from Rapid Transit to bus.)

3. a) Predicted and (b) measured effects on ridership of 1981 fare increas (show calculations; break down into ridership profile).

4. Past and recent data on effects of fare increases in other cities. (identify length of average ride, transfer characteristics; describe response of total revenues to fare changes.)

5. Discuss effects on ridership of level and quality of service on peak an off-peak ridership. How is this weighed in ridership loss projections?

6. Discuss effects on ridership of availability of alternate transportatio Does it play a significant enough role to warrant incorporation into riders loss projections?

7. Assess and articulate the role of elasticity and analysis in operations planning. How useful is it? What are its limitations, and how can these be avoided?

III. Environmental Impacts of Ridership Losses

1. Data preparation: transform estimates of ridership loss into estimates of increased vehicle miles travelled (VMT). Discuss methodology.

2. Apportion estimated VMT increases to main corridors into, out of city; where possible, apportion onto routes within city. This part of the study should utilize Tunnpike bridge and Tunnel toll information, MDPW traffic counts, and data on parking lot use. In addition a special effort should be made to verify calculated increases, by random checks with individuals having first-hand experience (toll-takers, police, TV helicopter newsmen, auto commuters).

3. Increased Traffic Congestion: Estimate congestion increases for I-93, Expressway, Mass. Pike, Storrow Drive. Discuss congestion increases at selected intersections for which detailed intersection data are available (e.g., Blue Hill Avenue and American Legion Highway, Commonwealth Avenue at the B.U. Bridge, Cambridge and Staniford Streets, Science Park). Assess potential for indirect impacts of increases traffic on local streets.

4. Discuss sketch planning techniques for assessing air pollution impacts of increases VMT and increased congestion.

5. Assess air pollution impacts of ridership losses (1980 and 1981, aggre by reference to a) areawide increases, and b) selected intersections identified as CO hot spots. Discuss compatibility with SIP.

6. Energy: Assess change in energy usage resulting from 1980 and 1981 ridership losses (both fare increases and service cuts).

Alternatives

The EIR should formulate a series of alternative fare structures, both those ited to existing funding and those which would be dependent on additional ing. I suggest that the following would warrant examination:

1. No action or prior fare and service structure (July 1981) with budget shortfall, and what it means for service quality and continuity.

2. Fare increase as implemented on August 1, 1981 and effective for November 1981, including partial restoration of service cuts.

3. Modified fare structure.

   a. Free or reduced transit fare for certain groups

   b. Peak period pricing, including past experience with Dime Time and implications of current off-peak free elderly travel

   c. Lower rates for transfers

   d. Lower fares for downtown distribution (refer to practice in other cities).

   e. Pre-paid or self-service bus fare system (analyze potential reduction in travel time and resultant increase in service)

   f. Timed transfer points, route consolidation, posting schedules at stops.

Discussion of the above options should include a description, statement of ls and potential advantages; discussion of feasibility and operational problems; cussion of un-wanted side-effects and potential avoidance mechanisms, ability stimulate ridership, and effect on revenues.

Mitigating Measures for Fare Increases, Service Reductions, Increased Auto Use

A. Operational Changes (discuss feasibility, programs in effect, programs under consideration.) Procedures for route evaluation should be described. Analysis of specific routes is outside the scope of the EIR, although it may be a necessary part of the SIR where especially severe impacts are identified.

   1. Service restoration

   2. Service quality improvements, with the goals of more frequent and reliable service, less crowding and higher travel speeds. current implementation status of 1977 MBTA Service Policy

   3. Describe current or proposed productivity measurement programs:

      Service Policy for Surface Public Transportation
      Rail Service Standards
      Service Evaluation Project (SENTRY)
      MBTA Systemwide Passenger Data Collection

Identify performance criteria, methods of monitoring results. This information plus means of monitoring individual or group achievement, will be an important component of the Management Practices Study, but descriptions of the programs should be assembled and included in the EIR, due to the importance of such evaluation in mitigating impacts.

4. Other

B. Changes requiring legislative action: provide conceptual discussion of proposal disadvantages (including cost effects), history of previous attempts, if any; discuss whether action will be sought.

1. Human Service user-side subsidies of special needs, lower income.

2. Cost-of-living price indexing

3. Sales tax, gas tax funding

4. Other

VI. MBTA Expectations for Short-Term and Long-Term Service and Fare Stability Over the Next Decade.

Discussion of planning and operating goals and methods to achieve fiscal stability for the MBTA.

October 30, 1981
DATE

JOHN A. BEWICK, SECRETARY

JAB:SGM:cg

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, Massachusetts 02202

WARD J. KING
GOVERNOR
IN A. BEWICK
SECRETARY

PROJECT NAME:	System Wide Fare Increase
PROJECT LOCATION:	Statewide
EOEA NUMBER:	4147
PROJECT PROPONENT:	MBTA
DATE NOTICED IN MONITOR:	July 7, 1981

SCOPE OF SOCIOECONOMIC IMPACT REPORT (SIR)

I. Introduction: Articulation by MBTA of socioeconomic values of public transportation

A. Values to users: access to place of employment, to education, to health services, to recreation/socialization, to necessities

B. Values to business/commerce: access by customers, employees

C. Values to neighborhoods, political units: ecomomic health, tax base, growth vitality

II. Statement of study goals

1. shared understanding of effects of fare, service actions on socioeconomic values

a. issue definition

b. data collection
c. filling gaps in data
d. evaluation of implications

2. dialogue, feedback evolution of ideas

3. proposals for future action

III. Identify Categories of user; discuss reasons impact evaluation is(or is not warranted:
low-income persons
students
elderly - not employment related
youth, not school related (break-down: half-fare youth, full-fare youth?)
discretionary riders (shoppers, tourists, entertainment, other?)
commuters - captive, discretionary
handicapped

Data exist for most of the above; where data do not exist, estimates or worki assumptions should be made.

IV. Give figures, for such user categories, of ridership prior to 1980-81 fare ir creases and service cuts, and figures for such ridership subsequent to such increases and cuts. Apportion into trips diverted and trips not taken.

V. Discuss impacts on user categories of trips not taken. (Discussion is expected to be qualitative, due to lack of hard data, but should nonetheless be helpfu in identifying comparative severity of impacts on user categories)

VI. Increased dollar cost

A. State, for each user category, the change (absolute and %) in cost of tri taken. Establish a common factor (probably, fare burden/household income to permit comparison of change in burden of fares borne by each user cate

VII. Discuss impacts on user categories of increase in proportion of household inc devoted to transit fares. Which, if any, increases are negative when correct for inflation?

VIII. Existing Subsidies

Describe existing fare programs for the benefit of any of the user categories discuss any state or federal regulations which mandate them. Assess cost to T of these programs, and compute and compare on a per capita basis the effect of these subsidies on user categories.

IX. Mitigation Measures

Identify any user categories which are believed to be either disproportionate burdened (insufficiently subsidized) by the fare structure, or any ways in wh

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* (or other common factor, as developed)

the fare structure is believed to inefficiently deliver the present subsidies, and discuss proposals for remedying the situation. Discuss short-hop travellers, especially those needing to link trips. Discuss inconvenience of paying by multiple coins, increased dwell time, increased fare evasion.

Estimate the impacts of the fare increase on retail trade.

. Develop a means of prior evaluation of potential service cuts or fare increases so as to identify and avoid actions having especially severe social economic impacts. Establish the procedure for this (SIR update for fare increases or service reductions; other means for any significant changes in service (c. 116A s. 5 (F 1/2)).

October 30, 1981
TE

JOHN A. BEWICK, SECRETARY

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APPENDIX A-4

COMMENTS ON THE DRAFT MBTA FARE STUDY AND RESPONSES

The following are the formal comments which have been received on the Draft Environmental and Socioeconomic Impact Reports of the Fare Increase on the MBTA, dated March 5, 1982, April 1, 1982, and September 1982. Responses as to where information may be found within the final report are provided where necessary. Policy comments are included without response for the reader's information.

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, Massachusetts 02202

EDWARD J. KING
GOVERNOR
JOHN A. BEWICK
SECRETARY

JUN 16 10 01 AM '82
PROGRAM
DEVELOPMENT

CERTIFICATE OF THE SECRETARY OF ENVIRONMENTAL AFFAIRS ON THE REVISED DRAFT ENVIRONMENTAL IMPACT REPORT

PROJECT NAME : MBTA Fare Increase

PROJECT LOCATION : MBTA Region

EOEA NUMBER : 4147

PROJECT PROPONENT : Mass. Bay Transportation Auth.

DATE NOTICED IN MONITOR : April 23, 1982

The Secretary of Environmental Affairs herein issues a statement that the Revised Draft Environmental Impact Report on this project adequately and properly complies with Massachusetts General Laws, Chapter 30, Section 62-62H inclusive, and the regulations implementing MEPA.

The original Draft Generic Environmental Impact Report submitted to this office on March 10, 1982, was prepared jointly by the MBTA and by the Central Transportation Planning Staff. The report was prepared in response to the general Scope issued on July 31, 1981 and the detailed Scope issued on October 31, 1982. The revised Draft EIR, dated April [illegible], 1982, was received on April 15, 1982. This revised Draft Report contained much of the key materials which were missing from the original Draft EIR and which resulted in a finding by EOEA of inadequacy of the Draft Report.

1. GENERAL COMMENTS

The rollback of the rapid transit fare from 75 cents to 60 cents and the Budget action of the Advisory Board has removed some of the crisis pressures from the MBTA management and its ridership. The summer and fall of 1902 should serve as a period to analyse and plan on ways to avoid future crises over funding, fare increases and service cuts, and to provide clear direction to the MBTA to achieve more stable and efficient service to the ridership.	
The Draft EIR follows the MEPA scope fairly closely, although the EIR should contain the scope itself. The report is fairly well organized, and the tables and charts are fairly clear to the reader. A subject Index would also have assisted the reader in looking for desired information. In several copies of the report, page 95 was missing.	• Now in Appendix A-3. • Has been added. • Problem corrected.

2. DESCRIPTION OF EXISTING SYSTEM

The section on existing conditions is a good summary of the MBTA system, although additional tables would be useful to describe the number of rail cars and buses for each line, plus those that are available for daily service. Section 2.9, "Operating Capacity" is listed in the Table of Contents but is not in the text. A good description of MBTA operating capacities is clearly needed in the Final EIR.	• Can be found in Tables 2-2 A and B. • Now may be found in Section 2.7.3. • Appendix G.
The differences in Table 2.5 between the two versions of the Draft EIR should be explained, apparently the result of including or excluding considerations of Commuter rail.	• Now explained in Table 2-10.
Cost figures for the MBTA should also clarify how capital costs are treated. Debt service on old bonds and accounting for Federal capital assistance should be included in the overall assessment, as well as the relationship of these factors to depreciation cost.	• In Section 2-5.
Table 2-7 indicates differences in operating expenses per vehicle mile between various transit systems. Why are rapid rail operating expenses at the MBTA three times higher than those for New York City? Five times more than Chicago, 3.5 times Washington, D.C. and three times those of Cleveland. Why are MBTA bus costs twice those of Pittsburg, which is a city with much steeper hills?	• Will be found in the Management Practices Study.

3. RIDERSHIP LOSSES

The Final EIR should include a description of alternate methods of estimating riders and an assessment of accuracy. The extended CTPS process of estimating ridership was a long and grueling process which few people understand and which is not likely to repeated on a frequent schedule, so that the MBTA can be closely reviewed, with an emphasis on clarity. In addition, consideration should be given to the several detailed questions on the ridership figures, noted in the April 28 , 1982 EOEA statement on the original Draft EIR, as well as the following comments :

- Ridership data from Table 2-2 for 1951-1981 for total system daily ridership seems inconsistent with trends for rapid rail daily ridership for 1950-1980. Table 2-2 shows a loss of only 34,200 daily riders from 1980-81, while table 3-1 shows a loss of 94,600. An explanation is needed.

- Clarify the ridership figures and status of the Symphony station on the Green Line.

- The EOEA scope called for a "Comparison of peak hour quality of service (average speeds, passengers moved per hour) with off-peak performance, and with theoretical operating capacity of a system operating efficiently..." Appendix D deals very briefly with theoretical transit capacity, and rather lamely concludes that "there is no accepted theoretical capacity of a system operating efficiently." The 1977 Program for Mass Transit, Volume II contained a whole chapter on MBTA system theoretical and actual capacities. This information should be presented and used as the basis for the development of ridership-based performance standards for the MBTA.

- A key ingredient in determining capacity is the "crush load" capacity of each transit vehicle. There is a notable discrepancy between the EIR (page D-2) and the PMT (Chap.4, page 2) for the capacity of a Green Line LRV. The EIR figure is 56 seats and 217 standees, while the PMT indicates 52 seats and only 108 standees. The "crush load" has been defined as 1.5 s.f. per standee; what is the measured capacity of a fully loaded MBTA LRV?

- The ridership loss is produced by the difference in the 1981 and 1980 total ridership. Because of the sampling program in 1981, the estimates of 1981 ridership have been assumed to be more accurate than the 1980 figures, for which no sampling data were available. However, the variations in the 1981 ridership figures are perplexing :

November 1981	January 1982 CTPS	April 1982 DEIR
UNLINKED RAPID TRANSIT TRIPS		
Adult -- cash	51.2 %	48.5 %
-- prepaid pass	32.5 %	29.2 %
Elderly/Handicapped		
-- 1/2 fare	3.1 %	3.8 %
-- free	7.6 %	11.1 %
Students	4.6 %	5.8 %
Other Free	1.0 %	1.6 %
Total Trips/weekday	337,300	305,700

- Has been corrected.

- Appendix C has been re-written.

- See Appendix C.

Meanwhile, the surface percentages remained the same but the number of daily surface trips rose from 376,600 to 422,100. Total ridership rose from 713,900 to 727,800 unlinked trips. These variations should be explained, including the allegations that elderly ridership may have been exaggerated.	• The changes in calculations are contained in Section 3.4 and Appendix E.
• How do the annual ridership figures (1980 and 1981) take into account the fact that fare increases occurred during the middle of the year?	• The ridership figures are annual estimated values which need not be adjusted for fare increases.
• The variations in ridership estimates reinforces the need for a more accurate ridership measurement and reporting system, which provides ridership and revenue information in a timely fashion, without the typical delays of 2 months in information processing.	
• On page E-7, a loss of 32,000 daily riders (or 5.3 % of the total) is claimed due to service cuts. How was this figure derived and how does it compare with the 7.4 % figure cited in earlier documentation? The revenue mile data on page 36 indicate a 10% drop in 1980-81 service, as measured by revenue miles.	• The service cut loss was re-calculated with the elasticity analysis contained in Section 3.3.
• ELASTICITY :	
1. The Scope for the EIR explicitly called for a clear explanation of elasticities : "if both arc elasticities and simple elasticities are used in the EIR, avoid commingling them." Nevertheless, on page 43, data are presented on a "range of elasticities that could be applied to Boston." Do these represent arc elasticities or point elasticities? Also, do the fare elasticities on page 126 represent arc or point elasticity?	• The report has been simplified and now only inclues arc elasticities.
2. On page 46, elasticities are shown for various unlinked trips. Are these figures derived from comparisons of 1980 and 1981 ridership? If so, what allowance was made for inflation?	• Elasticities are static measures and are not "adjustable." They are calculated separately for November 1980 and 1981 in Section 3.3.
3. Additional comments on elasticity in the EOEA statement on the original Draft EIR should also be responded to in the Final EIR.	• Has been done with the expansion of Section 3.1.
In conclusion, it does not appear that the MBTA can be more accurate than 10% certainty in estimating its daily ridership. Elasticities are even more uncertain when concurrently with fare increases there are service variations and major inflationary increases in the price of gasoline and overall costs of automobile transportation. The Final EIR should describe methods of improved annual sampling of ridership and to improve regular pass-reader reliability and reporting, as well as more	• Discussed briefly in Section 7.0.

4. ENVIRONMENTAL IMPACTS

• TRAFFIC CONGESTION	
The methodology to assess incremental impacts on existing traffic congestion and queues is innovative and a worthy assessment of the impacts of additional traffic at key bottleneck points. Table 3 in Appendix F-1 should be clarified and made as consistent as possible with Table 4-1 on page 54.	• Has been corrected.
For Table 2 of Appendix F-2, hourly bottleneck capacity is "defined as 10 times hourly capacity," yet in the printed text it is the "hourly capacity at the bottleneck point." Please explain and correct as necessary. On page F-7, how is the average maximum delay measured and over what distance?	• Explained in Appendix F-2.
Is there any way of checking the queuing model, such as assessing additional traffic and queue lengths on the Southeast Expressway during the April 9 wildcat strike?	• No, data detailed enough to perform such a check was not collected during the strike.
• AIR POLLUTION	
On page 52, the additional regional air pollution emissions due to the loss of transit ridership is shown for non-methane hydrocarbons, carbon monoxide and nitrogen oxides. However, many autos, especially older models, release Lead Bromide as a particulate emission. Lead being a hazardous heavy metal with a prolonged impact on the environment, the incremental emissions of lead should also be estimated.	• Lead emission estimates have been included in Section 4.2.4 and Appendix F-6.
• NOISE	
The analysis on page 58-59 presumes that the only noise impacts will be from major roadways. If new traffic demand is added to already congested expressways, there is a noted tendency for traffic to divert to local streets and thereby have a more significant impact on residential areas and institutions.	• Section 4.4, Noise Impacts of the Fare Increase.
• ENERGY	
Table 2-10 on page 37 should include the data for 1981 as well, which suggest an additional improvement of 4% in fuel efficiency between 1980 and 1981. How have these improvements been achieved and do they include the closure of the South Boston Power plant? What additional steps are being taken to reduce energy waste and theft? The 1981 energy use reductions would appear to represent about 1/3 of the addition revenues generated by the fare increase as shown on page 32.	• See Section 2.7.1, Energy Use and Efficiency.
If the MBTA improved service revenue mileage by 10% to handle 10% more ridership, what would be the energy efficiency of such a change, compared with autos and private buses?	• See Section 2.7.1 and Appendix F-4, the Marginal Energy Consequences of Changes in Revenue Mileage.

On page 60, the energy consequences of the fare increase are estimated to be an additional 4.7 million gallons per year of increased auto fuel consumption. However, this estimate is based on an overall average of 15 MPH for each vehicle and does not consider the effects of increased congestion on energy consumption. The increased congestion will have an effect on more cars than those directly involved in the mode switch from transit to autos.

The combination of the EIR and SIR can result in useful measures of passenger and energy performance of the MBTA system. The SIR notes on page 116 that the average trip length on rapid transit is 7.1 miles and is 5.2 miles for surface trips. The table on page 115 could then be expanded to include :

Year 1980 155.6 million passengers	ANNUAL FIGURES IN MILLIONS Operating Cost	 Total Vehicle -Miles	 Total Passengers	 Passenger Miles	Cost per Passenger -Mile	Pass-Miles per gallon
Rapid Transit	$106.4	10.11	72.0	486.0	$0.27	-
Surface : Streetcar	$ 16.4	5.15	26.9	137.2	$0.12	-
Trolley Bus	$ 3.9	0.81	- 2.1	10.8	$0.36	-
(TOTAL ELECTRIC	$126.7	16.07	101.0	634.0	$0.20	22)
Diesel Bus	$ 85.8	22.22	58.1	296.2	$0.35	38
Commuter Rail	$ 41.2	5.79	?	?	?	?

The calculation above assume twice the number of riders per streetcar as for bus, on the average, and results in average occupancy of 48 passengers per rapid transit car and 13 passengers per bus. Do these figures check against sample trip observations of average load factors? The figures of 7.1 miles and 5.2 miles for the average rail and surface trips appears to be high, as do the figures for average vehicle occupancy.

- See Appendix F , Energy Consequences of Traffic Congestion.

- These are national figures for round-trip transit values, as now explained in document.

5. ALTERNATIVES

• ALTERNATIVE FARE STRUCTURES

The scope called for past and recent data on the effects of fare increases in other cities. Although a few cases were cited in the Draft report, a comprehensive summary should be provided in the Final EIR

- Can be found in Section 5.3.

The Draft EIR presenting some remarkable estimates of increased elderly ridership. Table 5-1 on page 84 provides the base data to calculate the incremental cost for each new rider due to fare reductions :

FARE REDUCTION	COST FOR EACH ADDITIONAL RIDER
Elderly : Free Off-peak	20 cents
Free Bus-to-Bus transfer	$2.90
1/2 price for low-income households	$3.15
Free Rail-to-Rail transfer	$4.00

The basic calculations on pp. 70-71 should be reviewed for accuracy. The 1980 elderly ridership of 45,000 (paying half fare) had an average fare of 16 cents (60% paid 10 cents for bus and 40% paid 25 cents for rapid transit) while the 1981 elderly ridership is estimated to have increased to 59,000 for an average fare of 15 cents. These results are not consistent with an assumed fare elasticity of 0.14. The data from Table 2 are not much better : 1980 elderly ridership of 46,300 with an average fare of 16 cents and 1981 ridership of 62,300 with an average fare of 12.3 cents. In either case, elasticities exceed 1.0, which is not a reasonable result.

- Has been reviewed.

Regardless of the specific ridership figures, the popularity of the elderly off peak ridership program should be recognized by proper amendment of chapter 161A of the General Laws, which currently requires that elderly riders pay one-half of the full adult fare on both subways and surface lines.

Programs to increase off-peak ridership and spread the service more evenly throughout the day have been proposed. What are the costs of current service per off-peak revenue mile compared to peak conditions? The costs and benefits of off peak scheduling should be assessed on this basis.

- Information was not available.

6. SOCIO-ECONOMIC IMPACTS

Most public comments on the socio economic impact section of the report have been generally favorable. However, the degree and form of subsidy remains unresolved in terms of specific plicy for service and system improvements.

The proposal for a human services or education agency to redistribute subsidized tokens does present certain practical problems. The school program has produced a black market in tokens, as many students sell their tokens for cash. The same result is likely for tokens to the elderly and handicapped.

One key assumption of the Report is that the subsidy is virtually entirely in the direction of low income and disadvantaged persons. The flat fare structure tends to place a larger percentage of burden on lower income passengers. [illegible] [illegible] trend over the years towards suburban rail transit extensions has tended to provide the suburbs with better service to the detriment of the inner city and also the inner suburbs.

In the Final Socio-economic Impact Report, the EIR should seek to respond to the specific comments received and the implications for optimizing the proportion of subsidized service to various disadvantaged segments of society.

7. MITIGATING MEASURES

This chapter lacks quantitative analysis. There are no figures for standards or for actual performance results. Page [illegible] refers to productivity criteria such as passengers per hour and revenue per passenger mile. How are these factors to be [illegible] and what are the characteristics for the existing MBTA system? What are the performance criteria which the MBTA would propose especially for rapid transit, and how well has the MBTA met these goals in recent years?

Detailed comments on load factors, and bus route [illegible] included in the specific comments of the Study Review Committee and EOEA statement on the original DEIR.

- Can be found in Appendix C.

• ALTERNATIVE FUNDING SOURCES

The EIR considers several alternatives to fare increases, including fare collection methods, new taxes and implementation of management rights. The concept which appears implicit in management rights is the improvement of operational efficiency of the MBTA. For the same amount of employees and rolling stock, improved efficiency will generate new riders and new fare revenue. The benefits are two fold [illegible] revenues and [illegible] ridership, with reduced auto tripmaking and associated [illegible] pollution, congestion and energy impacts. The Final EIR [illegible] explicitly and quantitatively look at

- Addressed in Section 7.0 and tangentially in Section 2.7.3.

The goals should be to utilize trains and buses in the best way to move the most passengers during peak periods, to invest in preventive maintenance rather than the more crippling failure maintenance, to cut back on energy waste and theft, and to improve monitoring of operations in the field.

* CONTROLLING COSTS

The general issue of controlling costs was covered in the EOEA statement on the original Draft EIR, and is considered in more detail in the response to the Draft Management Practices Study.

* * * * * * * * * * *

The Final EIR should include copies of the public comments received on both the original and the revised Draft EIRs and copies of the various scopes issued for the MBTA fare increase. A topical index at the end of the report would also be very useful.

6/4/82
DATE

JOHN A. BEWICK, SECRETARY

SGM/SK/ze

May 11, 1982

Comments on the Revised Draft Environmental and Socioeconomic Impact Report of the Fare Increase ob the MBTA.

To: Samuel Mygatt, MEPA Office

From: Anne Fanton, LWVM

The League of Women Voters of Massachusetts asks that Secretary John Bewick find the Revised Draft EIR and SIR unacceptable without substantial revisions by CTPS. Despite extensive comments, by SRC members, made at our meeting on March 24th, the Revised Draft is nearly identical to the Preliminary Draft except that missing sections have been inserted. A few other minor changes were made in the text, most not in response to committee comments. It appears that the entire report was retyped and reprinted, which seems particularly wasteful in light of the lack of actual revision.

All of the comments I submitted to you on April 6th are still applicable with the exception of: p.4, the map has been corrected; p.14, MBTA as source added; p.17, Symphony ridership # simply removed (is data valid?); p.23, Zone 2 corrected.

Additional Comments on the Revised Draft:

p.27 - All of the numbers in the top paragraph have been changed, without any explanation. They now do not correlate with the bottom paragraph on same page.

p.28 - The last 4 columns of figures were all lowered, without any explanation.

p.30 - 1981 figures were added but revenue figures still do not correlate with those on p.32! Some explanation is necessary.

p.31 - This chart has been added and is very useful. Also, the source is provided!

p.34 - Line 10 has been clarified.

p.36 - 1981 figures were added.

p. 54 - Figures for additional VMT and regional emissions have been revised upward, without any explanation.

p.56 - some changes.

Socioeconomic Impacts, pp.93-127:

General Comments:

The SIR offers some very useful information and there is considerably more source identification than in the EIR, though much of its data still needs [illegible].

- This section has been recalculated. Error made in previous values had included non-MBTA operated carrier services.
- Changed.
- Relates to same error; has been corrected.
- Lowered, had been an arithmetic error.

to be explained in more detail. One of the primary goals of this study was to define the need for accurate ridership data, to determine the impacts on specific groups of riders when making changes in fare structure or service, to state where there are gaps in such data and offer recommendations for closing these gaps. The Draft SIR does not do this. If ther is adequate data, there is not enough information in the report to verify this; if there is noneedough better data, then it would serve the purposes of the report for the MBTA to make the needs clear. The purpose was to be constructive, not defensive.

Specific Comments:

p.93 - The introduction seems well written.	
p.95 - missing; therefore value to users could not be evaluated.	• Has been added.
Section II of the SCope of Work does not seem to have been done.	
Sections III and IV of the Scope of Work call for identification of categories of users and figures for each category. Section 6.2 of the Draft SIR would be much improved if these categories were presented all together in one chart, with percentages on the system.	• Comparable information to create such a chart beyond what is provided in Table
pp.99-101 - Tha income discussionis very useful. On p.100, where did the 1981 sigptzugopeogram? Did the 1981 fagepling program categorize riders?	• No, not into income group. The information was estimated as described in Section 6.2.1.
p.102 - How were the school and non/school numbers generated? "It is a fair assumption"; "In 1981, it is estimated" need explanation. An appendix describing the Nov., 1981 sampling program in detail (percentage vehicles for each mode sampled; evaluate it for reliability; discuss other (more reliable?) sampling methods that could be implemented.)	• This memo will be available from the MBTA in a separate technical memo soon after October 1, 1982.
(Refer to Comments below on Appendix E. Note that at the bottom of E-5, it is stated, "Care should be taken when using figures concerning the subcategories of users." Yet, the SIR sues these fidures, has not discussed their adequacy, does not recommend methods of collecting more accurate data to improve the figures, and (apparently) has made assumptions based on these figures.	• Sampling program was an attempt to generate more reliable numbers from 1981 on.
p.104 - Explain the means of estimating elderly ridership. The assumptions in the last paragraph also need substantiation.	• Section 6.2.2 explains the method and assumptions.
Perhaps, considering the data that exists, the author made reasonable working assumptions. More emphasis in this section then should be placed on improving the data.	
p.110 - What evidence is there that 11,500 - 16,700 lost trips went to other shopping centers? The focus was to be on the city's retail trade.	• 1979 shopping trips are estimated through use of the 1978 Wilbur Smith Study and 1981 figures are derived by applying elasticity analysis as shown on Table 6-1 and Table 6-7.
pp.115-117 - I am not sure why this work was done. Is this to fulfill Sections VI and VIII cd the Scope of Work? Does it? I am confused by this. Also, the Palmere study (see footnote, p.123) could have been useful resource here.	• The Palmere Study was used and is now properly cited.

p.120, line 4 - This eases past a real legal question re. the elderly fares. State law"requires that ½ fares be charged (not offered) to the elderly at all times."	
p.121 - What was the source for the data on children and students, and on fare evaders? (Source identification should bemmore than just "MBTA". Identify specific study, or means of gathering data.)	• Has been cited where known.
p.123,parag. 2 - I do not believe that the comparative regressivity of the fare burden per household income to various other tax burdens is "outside the scope of this analysis." Since fare increases are most regressive, that is some justification for mitigating measures and for reconsidering certain fare changes.	
p.124 - "Increased fares tend to affect the elderly more...." This is an assumption made prior to the fare increase. A major goal of the SIR was to evaluate free off-peak travel for elderly and handicapped, other mitigating measures and recommend the most effective and the cost-effective!	
Appendix E: A more detailed explanation of MBTA ridership counting procedures and the 1981 sampling program would improve the report tremendously. Recommendations for improvements in data collection could be placed here. Appendix E: E-2, bottom of page - How large was the sample? What percentage of total daily runs for each mode? E-3, top half - Confidence interval? Why? Does the technical appendix provide this information? Could it be added?	} • This more detailed study of the 1981 Sampling Program is contained in a separate technical memo to be released by the MBTA in the Fall of 1982. It contains all requested information.

The League askd that Sec. Bewick require CTPS and the MBTA to provide the additional information requested in written comments on the EIR and SIR, before accepting the draft reports. We thank you for the interest that EOEA has shown in this process, and the substantial time and effort that has been dedicated constuuctive improbements to the MBTA.

April 6, 1982

Some comments by members of the Study Review Committee on the Preliminary Draft of the Environmental and Socioeconomic Impact Report of the Fare Increase on the MBTA:

GENERAL COMMENTS:

Clark Frazier: 1. The document needs a stated policy. If policy has been enunciated in other certification documents, it should be included and referred to throughout this document. For example, would the policy suggest that decreasing VMT is a goal? There is no sense that permanently declining ridership is bad.	• Has been included; see Section 1.3.
2. We are expected to assume that much of the data is valid. (Lewjean Holmes stated that much of the data was taken directly from the MBTA with no attempt to validate it.)	• Attempt has been made to cite sources and check them where possible.
3. The document contains biased assumptions.	• Assumptions have been stated clearly where possible and are based on all available data.
Lewjean Holmes (?): The figures in various tables do not correlate. There should be consistency among figures within the document.	• All tables have been checked.
Anne Fanton: 1. Suggest a complete reference list at the end of the document with all of the facts footnoted. Any statements, assuptions and conclusions within the text should be defended in detail. It is impossible to tell how thorough the research was.	• Footnotes have been added throughout the document.
.. Remove politicized statements; for example on page 12, the last sentence is inappropriate and unnecessary. Other examples are cited below.	• Has been done.
3. The final conclusion that the MBTA must depend in the future on increased fare revenue, rather than, for example, on alternative tax revenues, is totally unsubstantiated and does not seem to be drawn from the data in the previous sections of the document.	• Discussed in Section 5.3.
Betsy Johnson: Overall, the E.I.R. says little new that can really help in making policy decisions; section 4 (Environmental Impacts) especially is merely a "plugging in" of numbers into formulae. Analyses do not go anywhere. Are the decreases in ridership, increases in pollutants, etc. contrary to policy?	• See Section 4.2.5 and Section 4.3.
Ann Hershtang: Tables are expected to explain themselves.	• Additional explanations have been provided in many figures and tables.

SPECIFIC COMMENTS:

1. Appendix A - Summary of Studies (Scope 1.3.):

Frazier, Polly Russell, Fanton: more detail is needed, and a reference list at the end.	• See footnotes and bibliography.
Fanton: detail is needed in: p. 1, parag. 1: "Recommendations of the Governor's task force included ways to improve efficiency and reduce the deficit." p. 2, parag. 2 (all): beginning "The special commission...." p.3, parag. 2: explain "some concerns...about the distribution of the state's share of deficit to express service." p. 4: more detail in the top paragraph.	• Addressed briefly in Sections 2.7, 7.1, and Appendix A; also in Management Practices Study.

2. Section 2 -Existing Conditions (Scope I):	
Fanton: p. 4: This map is correct except for Acton and Carlisle.	• See Figure 2-2.
p. 5: define rapid rail and light rail.	• See Table 2-1.
p. 6: show Mattapan trolley line.	• See Figure 2-3.
Scope 1.4.: p. 10: remove political overtones - "Recently the MBTA (has been forced to reduce) reduced service."	• Removed.
p. 11: Green line number of vehicles?	• See Table 2-8B.
p. 12: Is this correct? Is bus service only 12-13% of what it was?!	• Yes, and see Section 2.4 for "de facto" service cuts.
There is nothing new here at all. A chart which clearly demonstrates 1979, 1980, and 1981 service levels with exact changes would be far more useful.	• See Table 2-6
Please see Scope 1.6.: Ridership. There are no ridership percentages in geographical parts of the system (necessary for the S.I.R.)	• In Tables 2-4 and 2-5.
p. 16,"Figure 2-6...notes the change from December 1980." how does it do this? Why is there no information on bus ridership?	• It does not; has been changed in the text.
Holmes: p. 17, Figure 2-6: stations that were closed have ridership noted (eg. Symphony). Are the numbers accurate?	• No, figure has been changed.
Steve Kaiser: p.18: Do the number of riders include pass users? This should be broken down.	• Yes, it does.
Hershfang: What is the resource for this data? Many tables suggest questions which are not commented on. All tables need additional information (eg. p. 37 closing of So. Boston power station was significant and yet there is no reference made to it. The energy service data does not explain itself!)	• Now explained in Section 2.7.1 on Operating Trends.
Fanton: p. 20, line 13: correct "the state passed legislation providing (a reduced fare) half fare to citizens over the age of 65."	• Changed.
pp. 22-27: Please refer to Scope I. 3.:	• Contained in 2.5.
This work is incomplete. The average fare is not compared to other cities and is not broken down into different fares for different passengers (eg. elderly, student, etc.) so that changes in the fare structure can be understood. All data sources need to be referenced.	• Information not available; will be in Management Practices Study in more detail.
Committee member?: p. 23: Zone 2 is incorrect.	• Corrected.
p. 27: Factor in length of trip as well as cost/trip. When talking about costs, footnote what is meant by "costs."	• Has been detailed, see Section 2.5.
Fanton: p. 30: The figures in Table 2-6 do not match those on p. 32 in Table 2-8.	• Has been corrected.
Refer to Scope I. 5.:Analytic methods is not done at all.	• In Section 3.1, 3.3, and 3.4.
Scope 1.7.: Operating Trends is incomplete. There are no conclusions. There may be "no theoretical operating capacity of a system operating efficiently" but CTPS can draw some conclusions from their examination of data. This section as written is useless.	• See Section 2.7.
3. Ridership Impacts of Recent Fare Increase (Scope II.):	
Russell: p. 40: The first sentence is blatantly political.	• Has been changed.

Fanton: This section is totally unacceptable: Please refer to Scope II. 1.-7. Numbers 1,5 and 7 are completed. Numbers 2 and 3 lack sufficient detail and there is no comparison with predicted effects. Numbers 4 and 6 are not done at all.	• No. 4 is presented in Section 3.2.4, No. 6 is included in diversion study. • Sections have been strengthened.
The conclusions are unclear, lack detail and back-up data. The ridership figures on p. 44 are new and leave serious concern as to their validity. The committee has neither the January CTPS report on ridership nor Appendix E. and I question whether there is any commitment at the MBTA to accurate information or improvements in data collection.	• See Section 7.1.3.
4. Environmental Impacts (Scope III.):	
Fanton: The air quality analysis methodology in the appendices needs to be more clearly written. Appendix F-2 is difficult to read and lacks data. Appendix F-4 ends in mid-sentence.	• Some re-writing has been done in an attempt to make the work more clear.
Was Scope III.2. completed?	• Detailed accurate data not available.
Scope III.6. (Energy) is not evaluated in a useful way.	• See new Section 2.7.1.
p. 50, 4.1.: How was the number 85,000 (decrease in daily passenger trips) arrived at?	• Diversion methodology is detailed in Appendix F-1,
p.57: last two paragraphs are very clear. The top line on p. 58 implies that the effect is not significant. Is that the conclusion?	• See new Section 4.3.
p.58, Energy: Conclusions? detail?	• Now in Section 2.7.1 and 4.3
Johnson: p. 50: It is unclear where the all-important 85,000 net decrease of daily passenger trips has come from, but all of the resultant numbers depend on this.	• Comes from estimates made with the assistance of 1981 Survey.
Some analysis of the pros/cons of EPA's MOBILE 2 program and volume 9 method as modified by DEQE is needed.	• Has been taken out.
pp.57-58: Most important, what is the significance of a 0.5% increase in regional daily VMT? What is the significance of an additional 200 tons/year of HC (actually it is unclear (p.57, sec.4.3.4.) if it is the HC or ozone or which standard which will be exacerbated.) The E.I.R. states that "the increase in emissions due to the fare increase is less than half of one percent of the reduction needed..." How significant is this?	• The significance of these values is discussed briefly in Section 4.2.5.
Hershfang: pp. 52-53: The arborway line is missing.	• ?
The League asked for comparative November 1980 and November 1981 garage use figures as maintained by various garages and traffic data for major radial highways, as an actual way of determining whether automobile use into the region had increased. May those be included?	• Data is not available on a regionwide, reliable basis.
5. Alternatives (Scope IV.):	
Fanton: p. 60, 5.1.: a very political section!	• Has been changed somewhat.
p. 66: The last sentence in the top paragraph does not follow logically.	• Corrected.
p.71, bottom of page: Doesn't the 1978 Passenger survey provide information "regarding the incomes of transit users and general travel patterns of the poor?" A 1977-78 Nationwide Personal Transportation Study conducted by the U.S. Bureau of the Census for the Federal Highway Administration provided such information. This is the kind of research necessary to the E.I.R./S.I.R. and some of this information is available right in the CTPS library!	• Section 6.4 on Fare Burden. • Information from this source is used extensively in Section 6.4.
p.85: description of fare structure alternatives is useful. Please add bulk sale of tokens as a possibility.	• See Section 5.4.2.

Ridership: p. 67: Impact of...Elderly - Could this be in a chart so that the various ridership figures - 52,000 45,000 27,000 32,000 and revenues and savings could be easily correlated and understood? Also, are these figures based only on "weekdays?" How many days a year?	• Now in Section 5.3.2.
p.68: seems to change to another subject in paragraph 2, and needs a new heading.	• Has been changed slightly.
p.71, Section 5.3.2.: Reduced fare....Groups - The student fare discussion here is about raising not reducing them. The Boston LWV requested that you include an analysis of the possibility of and consequences of providing ½ fare rides for children up to 18 at all times, not just school hours. We again request it.	• See Section 5.3.2 for an expanded discussion.
6. Socioeconomic Impacts: Fanton: No S.I.R. Wasn't much of the ridership data necessary for the S.I.R. also necessary for the E.I.R.? How could one be completed without the other?	• Now included as Section 6.
7. Mitigating Measures (Scope V.): Fanton: p.96,7.1.3.: Service Restoration: What service was restored during the summer and fall of 1981? Refer to EOEA #4147.	• See Table 2-6.
p.98,7.2.2.: Alternative Funding Sources: What references were used?	• See Bibliography.
p.99, last sentence in 7.2.2.: Fare increases are also "met with opposition." I suggest a review of Anthony Palmere's "Financing the MBTA" in the CTPS library. It contains detailed information on the impacts of fare increases and other alternatives.	• Source was reviewed and appropriate changes were made.
p.101: There is a total lack of information regarding the impact on ridership and the environment of fare indexing!	• ?
8. MBTA Expectations (Scope VI.): Fanton: p.102: "Increased reliance on fare revenue as a means of funding transit service can be anticipated" is an unsubstantiated conclusion. Was this section written in a void? This section was to draw its conclusions from all of the data and previous conclusions in the document.	• Yes, this section was originally written separately and has been better incorporated in final report.
Anne Fanton	

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, Massachusetts 02202

EDWARD J. KING
GOVERNOR
JOHN A. BEWICK
SECRETARY

CERTIFICATE OF THE SECRETARY OF ENVIRONMENTAL AFFAIRS ON THE FINAL ENVIRONMENTAL IMPACT REPORT

PROJECT NAME : MBTA Fare Increase

PROJECT LOCATION : MBTA Region

EOEA NUMBER : 4147

PROJECT PROPONENT : Mass. Bay Transportation Authority

DATE NOTICED IN MONITOR : October 7, 1982

The Secretary of Environmental Affairs herein issues a statement that the FINAL Environmental Impact Report and Socio-Economic Impact Report on the MBTA fare increase will be deemed to comply with Massachusetts General Laws, Chapter 30, Section 62-62H inclusive, and the regulations implementing MEPA, upon submission of a revised report meeting the following conditions :

1. Although the Final GEIR included and adequately responded to comments on the Draft EIR from EOEA (April 4, 1982), MAPC and the Study Review Committee, it did not include or respond to the following comments on the Draft Report :

* DEQE		April 21, 1982
* American Lung Association, Betsy Johnson		March 24, 1982
* Sierra Club	Original DEIR	April 21, 1982
	Revised DEIR	May 21, 1982
* Conservation Law Foundation		April 21, 1982
* Clark Frazier, S.R.C.		April 21, 1982
* Ann Hershfang, Boston L.W.V.		undated

The Final GEIR should be revised to contain these comments and respond to them.

2. The Summary of the Final GEIR (Section 1.2) was incomplete and did not reflect the high quality of analysis that went into the underlying document. The Revised Final GEIR should contain a complete and accurate summary.

3. Paragraph VB of the July 31, 1981 MBTA memorandum provides that :

> *"The mitigation and policy alternatives that are required to be identified by the MBTA will be binding upon the MBTA, unless the MBTA can show by 'clear and convincing evidence' why it has rejected those measures."*

The revised Final Generic EIR should contain a description, with page citation, of the mitigating measures identified in each of the three reports (see especially EIR pp. 119-128 and the Management Practices Study).

UPDATES :

Paragraphs IIB and IIIB of the July 31, 1981 Memorandum provide that the EIR and SIR will be updated each time that MBTA raises its fares or makes a major reduction in service. The next update, which should assess the environmental and socio-economic impacts of any new fare or service actions under consideration, should also respond to all comments filed on the Final EIR/SIR, and should report on the MBTA's success in implementing measures previously committed to. Three copies should be filed with this office, and the Update should be made available for the usual 30-day public comment period following publication in the Monitor.

Attached are comments on the Final Generic EIR/SIR.

December 27, 1982
DATE

Samuel G. Mygatt, for
JOHN A. BEWICK, SECRETARY

ANTHONY D. CORTESE, Sc. D.
Commissioner

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Quality Engineering
Division of Air Quality Control
One Winter Street, Boston 02108

April 21, 1982

RECEIVED

APR 26 1982

OFFICE OF THE SECRETARY OF
ENVIRONMENTAL AFFAIRS

Mr. Samuel Mygatt
Executive Office of Environmental Affairs
MEPA Unit
100 Cambridge Street
Boston, MA. 02202

Dear Mr. Mygatt:

My staff has reviewed the "Draft Environmental and Socioeconomic Impact Report of the Fare Increase on the MBTA." The basis of a consistency determination is an assessment by DEQE of the project in terms of the transportation project review criteria contained in the Transportation Element of the Massachusetts State Implementation Plan for Air Quality (see attachment). The criteria and the results of their application are as follows:

1. Consultation with the Department of Environmental Quality Engineering

   DEQE has been involved in the consultation process with CTPS and the MBTA since the study initiation. We participated in the project's scoping, and the actual preparation of the respective air analysis. This criterion has been met.

2. Performance of an adequate analysis

   Microscale and mesoscale analyses of the project were conducted. The microscale analysis was performed jointly by DEQE and CTPS utilizing the EPA Volume 9 modeling technique as modified by DEQE, traffic and meteorological input evaluated in terms of the report's documentation appear to represent worst-case conditions. Conservative background concentrations were based on DEQE guidance. DEQE finds the analysis adequate and in compliance with this criterion.

3. Hydrocarbon emissions

   The results of the mesoscale analysis is the basis for assessing a project relative to this criterion. The mesoscale analysis of the project indicates that hydrocarbon emissions associated with the fare increase are greater (200 tons/year) than those associated with the no fare increase policy. It is further noted that given the MBTA Fare Policy as described in Section 8.0 MBTA Expectations for Short-and Long- Term Service and Fare Stability Over The Next Decade, the problems as noted above may be further exacerbated. In light of these findings, commitments to mitigating measures are required in order to be consistent with this criterion.

- This has been added and is in Section 7. and in the Summary table in Section 1.

4. Carbon Monoxide

Assessment of this project relative to the substantive CO criterion must be made in terms of reasonable progress in eliminating existing violations and evidence of no violations at sites where violations do not currently exist, since both situations are found within this study. The analysis indicates that none of the intersections exceed the 1-hour standard of 35 ppm, although conditions at Leverett Circle approach 30 ppm. The 8-hour standard of 9 ppm would be violated at 3 intersections with the increased traffic volumes generated as a result of the fare increase. It is further noted that given the MBTA Fare Policy as described in Section 8.0 MBTA Expectations for Short-and Long-Term Service and Fare Stability Over The Next Decade, the problems as noted above may be further exacerbated, in fact may spread to other intersections. In light of these findings, commitments to mitigating measures are required, in order to be consistent with this criterion.

In summary, the MBTA Fare Increase EIR as presented meets only two of the four transportation project review criteria. Therefore, DEQE finds the project and its resultant air analysis, as presented in the Environmental Impact Report, inconsistent with the Massachusetts State Implementation Plan, until such time as the MBTA addresses the requisite CO and HC mitigating measures.

Very truly yours,

Kenneth A. Hagg
Director

KH/HOB/efj.

Enc.

cc: Donald Megathlin, MAPC
Arnold Sooleman, CTPs
James O'Leary, MBTA
Anne Fanton, LWV

- See Appendix A-8.

- Section 7, Mitigating Measures, indicates the status of the commitments.

1. BACKGROUND

The basis for a consistency determination for a highway project by DEQE is an assessment of that project and its environmental documentation in terms of the following project level criteria:

- consultation with the Department of Environmental Quality Engineering in the early phases of *project development*. Such consultation shall lead to agreement on the types of analyses to be performed and on the key assumptions to be used prior to performing the analysis.

- performance of an adequate air quality analysis. In terms of project development, decisions on the methods and assumptions to be used in the air quality analysis shall be reached on all major action projects prior to the major action designation.[2] Projects which are designated as *categorical exclusions*[3] and approved by FHWA shall be presumed to be consistent. Likewise, transit projects shall be presumed to be consistent. However, if a categorical exclusion project costs over $10,000,000, such project will be presumed to be consistent unless that presumption is rebutted by DEQE or the *MPO*. (See rebuttal criteria page.) Projects designated major actions prior to January 1, 1979 and for which agreement on the methods and assumptions used in their air quality analysis has not been reached, will be handled on a case-by-case basis.

- hydrocarbon emissions from the preferred alternative should be less than those from the no build case in both the short and long term; in cases where *hydrocarbon emissions* from the preferred alternative are greater, then all reasonable and feasible hydrocarbon reduction/mitigating measures shall be included.

---

[2] It was advised at the time of drafting the 1978-1979 DEQE-MPO Memoranda of Understanding on Transportation-Air Quality (MOU), the device by which affected agencies adopted these criteria, that agreement should be reached on analysis methods as early as possible in project development, e.g., prior to the major action determination. In practice, this has come to mean prior to the preparation of an environmental document. The MOUs will be revised to reflect this change, as part of the 1982 SIP revision.

[3] The 1978-1979 DEQE-MPO Memorandum of Understanding on Transportation-Air Quality (MOU), referred to categorical exclusions as non-major actions in accordance with FHWA/UMTA regulations. These regulations have since been changed and the MOU will be revised to reflect this change, as part of the 1982 SIP revision.

March 24, 75

TO: Ann Tanten, MBTA Study Review Committee Chair
FROM: Betty Johnson, environmental programs director, ALA of Boston
RE: Draft E.I.R. of MBTA fare increase

1. Overall the E.I.R says little new that can really help making policy decisions. Especially section 4 is merely "plugging in" of numbers into formulae.

2. It is unclear where the all-important 85,000 net of daily passenger trips has come from - but all of the resultant numbers depend on this

3. Some analysis of the pros/cons of EPA's MOBILE program and Volume 9 method as modified by DEQ is needed

4. Most important, what is the significance of a 0.5 increase in regional daily VMT. What is the signif. of an additional 200 tons/year of HC (actually unclear (p. 57, sec 4.3.4) if it is the HC or ozone which standard which will be exacerbated) The EIR that "The increase in emissions due to the fare increase is less than half of one percent of the reduction needed p. 57-58. How significant is this?

- See Appendix E, Estimation of Ridership losses
  The change in weekday transit ridership was estimated by dividing daily revenue, before and after the fare increase, by an estimate of the average fare paid by each rider.
  The loss in ridership cited in the preliminary EIR has been adjusted to 90,200 passengers based on a recent analysis of lost ridership experienced during the reconstruction of the Red Line's Dorchester Branch (DRTX Project).

- This method was decided upon by the groups who agreed upon the work scope. For more information on this topic a suggested source is:

  Emissions Forecasting Methodologies
  California State Air Resources Board;
  Evaluation and Planning, Sacramento,
  1974, available from N.T.I.S. PB-238259/
  6ST.

- This is explained in the summary section on Environmental Impacts and in Section 4.2.5.

SIERRA CLUB · New England Chapter
3 JOY STREET, ROOM 12, BOSTON, MASSACHUSETTS, 02108 · 617-227-5339

April 21, 1982

Comments on the Environmental and Socioeconomic Impact Report of the Fare Increase on the MBTA -- Preliminary Draft of March 5, 1982

This report was prepared by the Central Transportation Planning Staff. It consists of eight sections and seven appendixes. Section 6, Socioeconomic Impacts, and appendixes D and E, Problems, Estimating Ridership, and Estimate of Ridership Loss were not included in this draft, making an evaluation of these estimates based on the information that was included, impossible.

The Sierra Club finds the Preliminary Draft of the EIR unacceptable. The report does not carry out its introductory statement, "an analysis of environmental impacts associated with a fare increase." The report fails both in respect to analysis and to presenting environmental impacts.

The report is descriptive, containing a collection of documents and summaries of previous information. Relationships and effects on the environment are not analyzed.

Instead of presenting an analysis of environmental impacts, the report presents descriptive statements of the T's justification for fare increases (and service cuts) and promise that the T is making efforts to improve operating efficiency through the application of management rights and modern technology. The ten pages (out of the report's 105 pages) devoted to environmental impacts are vague and obscure.

This tunnel vision apparent in both the language and emphasis of the report focuses on the costs of operating the T in a time of inflation and decreasing tax funds. This is part, and an important part, of the problem of providing mass transit in the Boston area. The report lacks any vision that the MBTA has the opportunity to provide the most cost-effective and efficient way of moving people in a crowded urban situation. The report ignores what every resident within the MBTA area faces:

- * the greater cost of building and maintaining highways
- * the loss of tax money when valuable land is used for highways and parking lots
- * the inflationary impacts on the real dollars of personal incomes
- * the health hazards of residing in a congested urban area

The Sierra Club is very disappointed that this after-the-fact EIR doesn't present a balanced view of transit and doesn't provide the promised detailed information about environmental impacts. We expected important information which would provide a basis for policy direction helpful to the T. Decisions made by the MBTA now may affect residents of the greater Boston area for years to come.

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- Environmental Analysis and the environmental impacts of the increased (projected) VMT are a major portion of the final draft report.

- The work scope focuses on the MBTA budget and ridership problems, environmental impact of a chosen alternative, and mitigating measures to these impacts as they can be implemented by the MBTA.

Data and results presented in this report are not credible. Much is inconsistent , self-serving, contradictory, or clearly wrong.	
An example which demonstrates erroneous analytic technique: Table 2-1 MBTA TITLE VI information on page 11 purports to give the average age of the MBTA bus fleet. This trivial exercise in mathematical analysis is simply wrong.	
In this case, the data presented permit both a correct analysis and a reconstruction of the incorrect one given. The average age of the bus flee is computed in the EIR by averaging the average age of the busses assigned to each garage. The average age of the busses at each garage vary from 3.7 to 15.3 years. Because the number of busses assigned to each garage varies from 61 to 207 the fleet average age given (8.1 years) is wrong. The correct calculation which is found by weighting the average at each garage by the number of busses assigned to that garage, is 7.9 years.	• Has been corrected in subsequent review.
The implications for the credibility of the Draft EIR are devastating, because virtually all of the essential data and assertions are unsupported. If such trivial analysis is performed so incompetently, then no unsupported statement should be believed.	
We conclude that this Draft EIR should be withdrawn immediately and the mandated study be performed by competent and disinterested persons.	
Following are several areas where we have found serious problems:	
DATA	
Incorrect Data The 1981 Fare Structure Figure, Figure 2-9A page 23 is incorrect. The Zone 2 Fare should be $1.12½ instead of $1.00. Zone 3 Fare should be $1.50 instead of $1.25. The Sierra Club is alarmed that the ridership loss figures were estimated on the basis of such incorrect MBTA information; ridership loss might really be around 25% .	• Has been corrected in subsequent review. • Correct fares were used in the analysis.
Sources Omitted The report should be explicit about identifying the source of the data used. At the very least, a section should describe the surveys which produced ridership estimates, the data which was derived from these surveys and data which was derived from secondary estimates.	• Has been better documented. All tables include sources and additional information has been added to Section 2 Ridership Trends.
Missing Calculations How were the ridership loss figures presented in Section 2 turned into estimates of automobile trips in Appendix F? The assumptions are interesting, but it is difficult to see how these numbers have been used to produce the data presented in the charts.	• See Appendix F-1.
Confusing Presentations The Tables presented in Section III are confusing and contradictory.	• Have been revised and explained more clearly.

Sierra Club Comments on MBTA Draft EIR -- page 3

Contradictory Data Ridership numbers, using totals from Table 2-3 and Table 2-4 on pages 18 and 19 contradict the ridership totals shown in Figure 2-5 on page 15. The combined totals from Tables 2-3 and 2-4 show a decrease of approximately 53,000 between 1979 and 1980. Figure 2-5 shows an increase of approximately 30,000.	
Estimation Techniques not Specified The 1980 and 1981 figures for an average fare are not directly comparable to those prior to 1980, due to changes in estimation techniques. The average fare is an estimate of the "true cost" supposedly to facilitate comparisons but the changes in estimation are not described.	• This is now explained in the report, Appendix E.
Assumptions	
All assumptions should be clearly noted as such, and sources from which they were derived should be indicated.	• This has been done where possible.
The report claims that relative response to fare change does not depend on both the absolute and proportional magnitude of the change. The impacts of modest hikes cannot be generalized to more drastic ones, since a drastic hike is not typical.	
This EIR presents the belief that lost T ridership immediately join carpools!	
The increases in VMT reported on page 51 are key to the air quality analysis. The estimates presented cannot be evaluated without an explanation of assumptions. However, the data in Appendix F is cited without sources, and is not tied to the ridership figures presented earlier in the report. Which transit lines are considered to be in each corridor? Does Table 2 show the proportion or number of trips?	• Assumptions have been added where they would be useful. • Sources are now provided. • Transit lines are not divided by corridor. Corridors are based on origins and destinations. • Table shows percentage of trips.
Missed trips are assumed to have the same effect as service cuts in making further adjustments to fare inelasticity. This is a very questionable assumption since service cuts were designed to minimize a decrease in ridership. Missed trips and unpredictable service can be devastating to peak ridership.	• This has been further expanded in Sections 2.4.1 and 3.0.
Omissions	
Analysis of energy impacts	• Now included in Section 4.3.
Collections of air pollution data	• Original air pollution data collection was not included in the work scope. Forecasts of emission changes was the method chosen to estimate this.
Documentation of air pollution increases, specifically potential impacts of violation of HC standards.	• See Section 4.2.1 and Appendix F.
Salient points from the TSSTP analysis	• See Section 4.2.5 and Appendix F-1.
Analysis of health impacts on urban residents	• See Section 4.2.5, health effects are assumed to be considered in examination of emissions vis-a-vis standards.
Survey of riders to collect ridership input on alternatives to maintain or decrease ridership	• Alternatives are contained in Section 5. A survey was not conducted to determine riders' concepts on alternatives.

year in an attempt to minimize the environmental effects of the fare increase. However, no data is provided to support the estimates made. The resulting estimate of the amount of additional pollution to the Boston area as stated in the report, could be ten times less than the actual pollution. We cannot look at these numbers and conclude that insignificant environmental degradation occurs because of the MBTA's fare and service policies. In fact, the air pollution problem in Boston is such that even smaller increases in pollution result in increased hospital admissions and mortality, according to Dr. Betty Ann Brady, Children's Hospital. Therefore, the MBTA should be compelled to take steps to increase its ridership and should not be allowed to cause ridership to decrease.

Comments on Section 5

The Sierra Club finds that all of the material used in this section was available prior to the 1981 fare increase. The substance of the material in Section 4, limited though it is, was also available prior to the fare increase. The Sierra Club sees no reason why this information was not used by the MBTA prior to the fare increase.

This section does indeed "identify several alternative actions to the fare increase." The picture is not complete.
For example, reports show that the Washington DC peak period surcharge has been successful. This option is not mentioned in this section. Possible this method would be more successful in the Greater Boston area than in other cities. Certainly the two paragraphs covering this subject cannot be considered as definitive.

The fare alternatives are summarized in a cursory way in a narrow framework with uncited subjective judgments. Some cities have found good transit matches. Solving this problem will require more than this limited 23-page summary. When this report thoroughly and completely spells out all the impacts and problems for the MBTA, experts in the field might help the MBTA in developing a workable combination of alternatives.

Section 6 Mitigating Measures

We hope the T will make the promised improvements, such as implementing their already adopted service standards.

The public is likely to object to any cost-of-living fare increases until total operating costs are more reasonable.

In considering the alternatives which can provide the funds needed by the T, a complex economic picture must be examined.

In addition to streamlining the T's operating costs:
since 1/3 of the T's budget is fixed, sharp service cuts and steep fare increases may not be cost effective
* The T is a service which can save taxpayers money in other ways.

- By using primary standards for air pollutants, it is felt that health effects are inherently considered.

- This section has been expanded.

Page 25, last paragraph; It is hard to see how average fares relate to total linked trips. It would help if data describing the proportion of total linked trips can be ascribed to discount fares.	• Also, provided in CTPS Technical Report No. 39.
Page 29. Figure 2-10 is disturbing because it doesn't present the current picture. The upper chart apparently stops in May, 1980. If brought up to September 1981 the average fare per passenger would look quite different.	
Page 37. How did the T achieve the fuel efficiency shown in Table 2-10? It's clear that fuel consumption should be lower with service cutbacks. The statement that fuel efficiency has increased by 9% is unsupported.	• See Section 4.3 on energy use.
Comments on Section 3	
We cannot accept the present preliminary estimates of ridership loss.	
1. Evaluation of the ridership loss estimates cannot be made without Appendixes B and E.	• Now included.
2. MBTA ridership loss figures are in doubt. On page 14 it is assumed that 53,000 fewer trips were made because of the August 1981 fare increase. On page 50, a ridership loss of 27,000 from the first fare increase is indicated. This is the first and only mention of this number. Table 2-3 on page 13 lists a decrease of 55,000 on rapid transit alone in 1980. Where did the 27,000 come from? Why wasn't it mentioned before? What relation does it bear to the 55,000 in Table 2-3? We think the figure of 53,000 could be too low.	• See Appendices B and E including the DRTX Memo for a clarification of these numbers.
3. The whole discussion of elasticity is not really useful to this EIR. Elasticities should only be used for a projection. The elasticity arguments are circular. The ranges of elasticities on page 43 omit "e arc" or "e pt", so comparisons of the numbers on page 47 are impossible. There are serious difficulties in computing a single elasticity.	• This has been clarified in Section 3.1.
4. The statement that "Rapid transit elasticities are still significantly higher than expected... implies that service reliability might have been acting to discourage ridership" (page 47) should be examined further.	• This is discussed briefly in the report in Section 3.1.
5. Calculating even a gross ridership loss figure requires estimations of estimates and assumptions on assumptions. Under these conditions, different sets of assumptions must be presented and the range of estimated losses published. We do not accept the ridership loss estimate of 9163, four parts in one thousand below the trigger level for fare adjustments, which appears in this EIR.	• See CTPS Technical Report No. 39 for details on the assumptions.
Comments on Section 4	
Overall the EIR presented the best case outcome of the environmental effects of loss of ridership due to a fare increase. The report attributes much of the loss of ridership to the service cuts of the same	

Consideration of all options "Cost of MBTA service" section 2-6, should include some information on deficits per revenue vehicle. The T leads the nation with an operating deficit per revenue vehicle of almost $97,000. The range for five systems larger than the T is $30,000 --- $57,000.	
BIAS The EIR takes an unreasonably narrow view of the problems presented by the package of actions.	
Lack of Policy Framework. Without any stated transit policies it is impossible to evaluate the implications of the information in this report. In one section the report suggests that riders should be expected to pay total costs through fares. In another section on page 66, NYSDOT warns that ridership losses are not reversible. Without a policy framework, the number and selection of statements can bias the report.	• This has been added in Appendix A and in the summary.
Emphasis The ten pages out of a total of 105 allotted to environmental impacts cannot deal with the neccessary details and analysis. Many details of environmental impacts are omitted while we learn about nine bus garages and that the orange line proceeds northward.	
Partiality Explanations given support T actions, rather than specify problems so that better solutions can be developed.	• An attempt has been made to be more impartial and constructive in generating solutions that are feasible.
The many discussions of inflation and fares hammer in the fact that whether the T management was unaware of inflation until 1980 or unable to plan in the face of their own information. Reasons for not raising fares for several years are not given. It may be that past T management decided that it was politically expedient to rely on federal and state tax funds. No hint is given that the T could have responded to financial problems in 1980 and 1981 by examining all available options, including recommendations from from an EIR prepared in advance of any fare increase or legislative alternatives or streamlining the costs per passenger "increasing much faster than inflation")(page 27).	• See the section on Findings and Recommendations in Section 1.
Comments on Section 2 This section would be easier to comment on if some data were further evaluated.	
page 12. Shouldn't the next to the last sentence read "12% and 13% less than that provided in 1980?"	• Yes, it was changed.
page 16, last paragraph. How does this data compare with the Wilbur Smith surveys? Why not pull out the bus ridership figures?	• The data is from the Wilbur Smith survey.
page 22 top paragraph. Passes should be mentioned prior to this: how many are sold, their cost before the 1981 fare increase, and perhaps a	• Pass information was consolidated for purposes of estimating ridership. For more detail, see CTPS Technical Report No. 39;

Downtown and other business areas serviced by reliable public transportation may be revitalized thus producing more profit and taxes. Taxpayers will also save money by not building and maintaining more highways.

* *

The Sierra Club would like to see an inexpensive alternative to increase ridership implemented;

The T would post schedules and maps in appropriate places
Drivers and T personnel would provide schedules.
All transit would arrive on schedule!

Some Comparisons of the MBTA with the Chicago CTA and the Philadelphia SEPTA -- from Section IV Report by Urban Mass Transit Authority, 1973-1979 data

	MBTA	Chicago CTA	Philadelphia SEPTA
Annual train miles/ operator	5,000	7,100	14,000
Annual car miles/ operator	13,500	23,000	58,000
Annual car hours/ operator	340	1100	3100
Operating costs/ car mile	$11	$2.70	$3.60
Operating costs/ car hour	$250	$67.50	$67.50
Administrative employees/car	1.05	.3	.35
Total employees/ car	7.5	3.3	3.5
Annual operating costs/car	$236,000	$90,000	$80,000
Total Transit System			
Public assistance dollars/vehicle	$95,000	$45,000	$55,000
Ratio of fares: operating costs	25%	51%	39%

- The Management Practices Study addresses this in its Appendix A, Section III and presents a detailed comparison of staffing and expenditure levels for these other systems.

SIERRA CLUB · New England Chapter
3 JOY STREET, ROOM 12, BOSTON, MASSACHUSETTS, 02108 • 617-227-5339

May 21, 1982

Comments on the Revised Draft of the E.I.R., S.I.R. of April 1, 1982

The Revised Draft of the Environmental and Socioeconomic Impact Report of the Fare Increase on the MBTA contains some information – the Socioeconomic Impacts section, and the B and E sections of the Appendix – which was not included in the Preliminary Draft. The report uses unsubstantiated data and assumptions. This draft, like the Preliminary Draft, continues to make subjective assertions. We cannot accept technical analysis based on unclear data and assumptions.

The Environmental Impacts section is inadequate. Any qualitative analysis is impossible. The report does not specify the modeling procedures or the assumptions made. The model used for dispersion analysis is not adequately described. The algorithms and assumptions are not adequately described. Of special importance is the meteorological data including atmospheric stability conditions, and wind speed and direction data. The mixing height is not mentioned.

The contents of this Revised Draft could have, and should have, been prepared prior to the August 1981 fare increase, as required by M.E.P.A. Responsible advance planning could have prevented the unnecessary ridership loss, which has resulted in unnecessary negative socioeconomic and environmental impacts.

- All data sources have now been provided. Where methods were adapted from some other work, this material has been cited.

- A separate dispersion analysis was not conducted. The information used for CO Hot Spot Analysis has been expanded and additional sources are provided. Lead analysis has been added. Total emission increases have been estimated using the MOBILE2 method and have been disaggregated only to the corridor level. Meteorological data is not used in a model of this sort.

CLF

April 21, 19

RECEIVED

APR 21 1982

OFFICE OF THE SECRETARY OF
ENVIRONMENTAL AFFAIRS

Executive Office of Environmental Affairs
100 Cambridge Street
20th Floor
Boston, Massachusetts 02108
ATTN: MEPA Unit

Re: Preliminary Draft Environmental and Socioeconomic Impact Report of the Fare Increase on the MBTA, EOEA No. 4147.

Gentlemen:

The Conservation Law Foundation of New England, Inc. ("CLF") appreciates this opportunity to comment on the Preliminary Draft Environmental and Socioeconomic Impact Report of the Fare Increase on the MBTA. As the attached comments explain in detail, CLF requests the Secretary to find that this preliminary draft EIR does not adequately comply with the requirement for a draft EIR under MEPA and to require issuance of an additional draft EIR which is substantially improved.

CLF received the revised draft EIR only yesterday, so no assessment of the added sections is included in these comments. Additional comments on the revised draft will be submitted later.

Please contact us if you have any questions on the comments which follow.

Sincerely,

Stephanie Pollack

Stephanie Pollack

Jeannie Nachimson

Jeannie Nachimson

SP/JN/abg

Enc.

Conservation Law Foundation of New England, Inc., 3 Joy Street, Boston, Massachusetts 02108 (617) 742-2540

I. INTRODUCTION

The *Preliminary Draft Environmental and Socioeconomic Impact Report of the Fare Increase on the MBTA* is replete with omissions, inaccuracies, biases, miscalculations, and ambiguities. The document contains little more than compilations of existing statistics and studies; even this data gathering is incomplete, and the amount of actual analysis in the report is negligible. The usefulness of this report as a draft of a final EIR is therefore seriously impaired. CLF requests that the Secretary of Environmental Affairs find that this preliminary draft EIR does not adequately comply with the requirements for a draft EIR under MEPA and require issuance of a second draft EIR incorporating responses to the following comments.

The numerous and significant concerns detailed in the comments clearly illustrate the preliminary nature of this preliminary draft. A second draft, substantially improving this version, is essential if the integrity of the draft review procedure is to be upheld. The purpose of a draft is to present a reasonably complete and reviewable report for public comment, but this document does not fulfill this condition. To allow it to serve as the only draft before the final EIR would be a betrayal of the whole reason behind having a draft in the first place. The next version of this preliminary draft will be radically different if it seriously addresses a significant percentage of the more than 70 specific comments which follow. Agencies and individuals will therefore be commenting on an essentially new document. This new document should be considered the draft EIR, in order to allow adequate opportunity for review of the analysis presented before the final EIR is issued. A second draft will also increase the likelihood of the final EIR being complete and useful as a planning document.

CLF's request for the Secretary to require issuance of a second draft EIR is further supported by the MBTA's failure to submit two crucial appendices on estimation of ridership until the end of the comment period. Much of the analysis in the preliminary report proceeds from an assumed drop in ridership which is explained in these missing appendices. The revised draft, received by CLF on April 20, is simply the preliminary draft with omitted sections added and does not fulfill the intentions of the second draft CLF has requested.

The final EIR should fulfill two functions. First, it should serve as a planning document for future proposed fare and service changes. Second, it should analyze the impacts of the past fare increases and service changes so as to define mitigating measures for these impacts. James O'Leary, General Manager of the MBTA, committed the MBTA to fulfill those functions in the EIR when he promised that the following would be part of the report:

> The EIR will be updated by the MBTA every time it raises its fares or makes a major reduction in service. The EIR shall develop the process for the updating, and the criteria for determining what constitutes a major reduction in service.

- A revised draft E.I.R. was issued in September 1982 and included this information as does this final report.

> The EIR will include an analysis of the 1980 MBTA fare increase both alone and together with the August 1, 1981 fare increase, as well as the March 1981 service cuts. (Memorandum from James O'Leary to John Bewick in the Certificate of the Secretary of EOEA regarding the System Wide Fare Increase, July 31, 1981)

This preliminary draft EIR does not develop the process for updating of the EIR, nor the criteria for determining what constitutes a major reduction in service. It does not include an analysis of the 1980 fare increase or the March 1981 service cuts. As the following comments specify, it is incomplete in many other ways. The MBTA can do a far better job of creating a document which fulfills the primary functions of this EIR. The Secretary of EOEA can mandate the creation of such a useful document by requiring a second draft EIR addressing the comments of CLF and others.

II. EXISTING CONDITIONS, RIDERSHIP, ALTERNATIVES, AND MITIGATING MEASURES

The comments which follow pertain to all sections of the preliminary draft other than Section 4.0, Environmental Impacts, which is considered separately later. All of the sections include the same types of errors: missing and incomplete information, bias, and an absence of original work or findings. These problems are detailed below.

- This analysis is discussed in several places in the report and is now included in Summary(Sec. 1)and in Elasticity Analysis in Section 3.

A. Information Not Available

A significant portion of this Preliminary Draft Environmental and Socioeconomic Impact Report was not submitted by the MBTA for review by interested parties until April 12, and CLF did not receive it until April 20, the day before the end of the comment period. The unavailability of this vital data, particularly the entire sections on Socioeconomic Impacts and Estimates of Ridership Loss, greatly hinders any complete review of this document. The accuracy and validity of much of the information that was submitted for comment depends on the validity of the unavailable information.

The information unavailable in the preliminary draft includes the following items:

1. Section 6 - Socioeconomic Impacts.
2. Appendix B - Problems with Estimating Ridership.
3. Appendix E - Estimates of Ridership Loss.
4. Table 2-7 - Cost per mile of operation in different cities.
5. Average cost/passenger in 1981 and 1982, page 27.
6. Glossary of terminology and jargon.
7. Summary.

The first five items are included in the revised draft dated April 1.

B. Incomplete Information

A good deal of the data and discussion presented in this preliminary draft report is incomplete. This incompleteness not

- All of these items were included in the September 1982 version of the draft.

only hinders review of the existing data and renders the report less useful as a planning document, but results in failure to fulfill the principal purpose of thoroughly and convincingly assessing the impacts of fare and service changes on the MBTA. The following material should be provided or revised:	
1. State the source and date of each table and figure.	• This has been done.
2. Provide a clear statement of policy or mandate of the MBTA (Section 2.1).	• See section on MBTA Management Policy in Appendix A - Section 1.
3. Provide a more detailed and useful description of the budget process and the responsibilities and authority of each main character in the process. The description should detail what the words "controls," "reviews," and "approves" entail on page 3.	• Now included in Appendix A - Section 2.
4. Clear and comprehensive information on schedules is essential.	• A summary of major service changes appears in Table 2-6 "Chronology of MBTA Service Levels and Fares."
a) Provide current service schedules and service schedules before and after each major service change since June 1980, including the 1981 first-quarter service reductions and any restoration of service occurring thereafter. This data, to be put in an appendix in a coherent format, should be readily available from the MBTA; its unavailability leaves an impression that service and decisionmaking at the MBTA is on an ad hoc basis. The text of the report can then include a description of the major changes that have occurred in service. This	• A summary of line statistics for all rail lines and each bus route has been included in Appendix C - Section 2. In addition, load factors, included in Appendix C-1, is representative of service levels provided. • See Table 2-6.

document cannot serve as a basis for further changes unless this data is provided.	
b) Describe the overall policy of service. The "set of basic guidelines and methods for instituting service reductions" developed by the Office of Service Planning would be a helpful addition in an appendix.	• The MBTA Service Policy was used as the basis for service changes along with technical judgments based on data of ridership levels on each route. This process is detailed in Appendix A-5.
c) Table 2-1, MBTA Vehicle Assignments, is irrelevant without an accompanying schedule of runs. Moreover, the April 1, 1981 source date is outdated and confusing. How valid are those numbers today? Do they include 1981 first-quarter service cuts or not?	• See Appendix C-2 for schedule information. Also Tables 2-2 (A and B) have been revised Table 2-2A displays vehicles required before the service cuts and 2-2B after the cuts were made. Recent data may be found in a current issue of the MBTA Bus and Rapid Transit Service Reports.
d) The updated and relevant data from Appendix C on MBTA Load Factors should be extracted and presented in a clear, readable, and concise format which fulfills the Scope's intention.	• Dates have been added. The peak load table is presented in the format which is most useful for analyzing each route.
e) Table 2-11 in Appendix D, dated 1977, should be updated or omitted.	• It has been updated.
f) Verify or correct the following statement found on page 12: "The MBTA estimates that total service on buses is between 12% and 13% of that provided, in 1980."	• This has been corrected.
5. Describe in general the extensions under construction.	• They have been added in the text and in Figure 2-3.
6. CTPS states on page 25 that the 1980 and 1981 figures are not directly comparable to those prior to 1980. Yet the	

text of Section 2, Figures 2-5, 9A, 9B, and 10, and Tables 2-3 and 2-5, leave the clear impression not only that these figures are being directly compared, but that they are indicative of actual trends, even to the extent of having them on the same time line. If such use is to be made of noncomparable data, it is essential that an estimate of the degree and direction of noncomparability be made and the degree of confidence in that estimate be stated. In addition, any nonhomogeneity of data in a table or figure should be stated on the table or figure itself.	• Changes have made differences in data more obvious. • This has been done.
7. Describe how ridership counts were and are taken, and how often counts are scheduled (Table 2-3, Figure 2-6).	• See Appendix B and CTPS Technical Report No. 3 "1981 MBTA Fare-Mix Sampling Program: Analysis and Documentation" for more information.
8. The text states that Figure 2-6 displays boardings by station in November 1981 and notes changes from December 1980, but these changes are not apparent on Figure 2-6.	• Changes have been made in the text.
9. The word "cost" is used numerous times for different purposes in the report. Clarification of what costs are included is necessary each time the term is used.	• Section on Cost of MBTA Service has been revised to clarify this issue.
10. All cost figures on tables and figures would be more useful if shown, at a minimum, as real dollars, and preferably also in current dollars (Tables 2-6, 2-11, Figure 2-11).	• Real dollars have been added.
11. Indicate whether the range of elasticities presented on page 43 are arc or point.	• This has been corrected.
12. Discuss more thoroughly the quality of service effects on ridership. What were the changes in number of trips missed over the past two years (page 47)?	• This section has been expanded.

13. The Scope requires prediction and measurement of ridership losses due to 1980 and 1981 fare increases. In addition, James O'Leary guaranteed an analysis of 1980 service reductions.	
a) The effects of the 1980 fare increases and service reductions are sorely neglected in this report (Section 3.0).	• The 1980 fare increase has been included in the diversion models and the air quality impacts. The study of the effects of this fare increase have been combined with the 1981 increase.
b) CTPS states as a concluding sentence in Section 3.4 (Analysis of Ridership Loss) that "It appears that the combined effects of both fare increases on the rapid transit lines would explain the unexpectedly high ridership loss that resulted" (page 47). This conclusion needs further description and explanation as to how and why the riders' response to the combined fare increases was greater than the two increases considered independently and what this means for future increases.	• This statement merely reflected the fact that an elasticity analysis was not done for the 1980 increase separately. By the cumulative effect of the two increases, the total impact was greater.
c) The ridership loss (absolute numbers and percentage), disaggregated by bus, rapid transit, and combined trip, should be presented for service reductions and fare increases separately in Section 3.0.	• The elasticity figures, which were used to determine the effects of service reductions, are not available at this disaggregate level.
14. The aim of the text in Section 5.2 on Implemented Action is ambiguous.	
a) The amount of revenue expected to be and actually raised by the 1981 fare increase should be specified separately as it is obscured by the overall budget.	• This has been clarified in the text.

b) This section's focus on defining what, including service cuts, will have to be done because the budget is considered too low leaves an important question unanswered. Did the implemented action, controlled and defined by the MBTA, fail to meet its goals, creating the need for service cuts, or were the extensive service reductions always an inherent but hidden component of the implemented action? This relation between the 1981 fare increase and the service reductions must be further clarified.	• See Table 2-6. Service cuts were implemented prior to August 1981 in an attempt to avoid a fare increase by reducing expenses. When it became obvious that this strategy would not provide a balanced budget, a decision was made to increase fares. At that time, the MBTA committed itself to a gradual restoration of service.
15. The preliminary draft's discussion of peak period pricing is inadequate.	
a) State the original fares on lines reduced to 10 cents. By only stating that the Quincy Line dropped from 50 cents to 25 cents, it leaves the impression that all other lines went from 50 cents to 10 cents on dime time.	• Has been clarified.
b) Explain why Decision Research Inc. was unable to quantify any gain in ridership through reduced off-peak fares (Dime Time) but the MBTA was recently able to quantify a substantial gain in ridership by reduced off-peak fares for the elderly.	• Explained in more detail in Section 5.3.1.
c) Detail, with data and methodology, how the actual response of elderly to the new free off-peak fares was measured.	• See Section 6.2.2, Section on the elderly.

16. An estimate of confidence in the figures and conclusions shown on Table 5-1, Effects of Alternative Fare Structures - Summary, is necessary.

17. Section 7.0, Mitigating Measures, is of vital importance to this document and to MBTA planning. Mass. Gen. Laws ch. 30, § 61 requires that all feasible means and measures be used to avoid or minimize damage to the environment. James O'Leary guaranteed in the July 31, 1981 Mitigation Packet that "The mitigating and policy alternatives that are required to be identified by the MBTA will be binding upon the MBTA, unless the MBTA can show by 'clear and convincing evidence' why it has rejected those measures." This section summarily dismisses the effectiveness or practicality of mitigating measures. The binding nature of the mitigating measures might explain why they were preemptorily dismissed by the MBTA; nevertheless, this section will not be adequate until some effective and practical mitigating measures are defined.

a) This section is incomplete without defining the time schedules and preconditions for the efforts described to improve operating efficiency through the application of management rights and modern technology. For example, when will "The Authority, after full installation and implementation, have the means to accurately count all passengers and the ability to provide accurate information for

- Factors that cannot be quantified, such as "ease of implementation," were rated on an ordinal scale. A high level of uncertainty (± 50 percent) is associated with these rankings. The actual values listed in this table are approximations based on observations in other systems. Their purpose is to offer a basis for comparing the results of various fare structure programs.

- This is now included in detail and with schedules for implementation in Section 7.0.

scheduling, safety and security" (page 96)? What are the preconditions?

b) Section 7.1.3, Service Restoration, should include a description of to what extent the service restorations, outlined in the July 31 Mitigation Packet, were completed.

c) Section 7.2, Legislative Programs, should describe what steps have been taken toward having the relevant state agencies shoulder the subsidy payments now shouldered by the MBTA.

18. Appendix A, Summary of Studies to Improve the MBTA, should include a list of the title, date and chief author/instigator of each report written in 1970-81 to improve the MBTA.

C. Biases

This preliminary draft report includes a significant number of words, phrases, and assumptions which are not appropriate in an objective and useful planning document. The author should be careful to separate facts from MBTA rationalizations in writing this report and to guard against utilizing the convenient MBTA position as the only or final position. The author should strive to not create possibly incorrect impressions through the unqualified use of unanalyzed MBTA assumptions. The MBTA's rationale for actions can be included but only if MBTA sponsorship is credited clearly; the rationale should not be described as having a cause-effect relationship to the MBTA action.

- This is detailed in Section 7, Mitigating Measures.
- Information on Legislative proposals is available in Appendix A-7 and is expanded in Section 7.
- A listing of studies on the MBTA is included in Appendix A.

The following five quotes provide some examples of the pervasiveness of the bias in the Report. Although it would be an immense improvement if the author thoroughly edited out all such biased language in the actual writing of the report, the greater damage to the use of this report as an objective planning document lies in basic assumptions and analysis and not just the written word. These unfortunately cannot be edited, and can be traced to the close relationship between the MBTA and the author. The biased language is simply a symptom of a far deeper bias.

The following statements, with emphasis added, illustrate the use of unsupported, subjective, deterministic and/or irrelevant language in this report.

1. "The MBTA *has been forced* to reduce service in an effort to alleviate financial problems." (page 10)	• Has been changed.
2. "*Only* 21% of the funding for the MBTA is generated by the fare box revenue." (page 27)	• Has been changed.
3. "*The best estimate* of what would have happened . . . if a fare increase had not been implemented *is probably the MBTA's own estimate* presented in the ENF." (page 60)	• Has been changed.
4. "Additional service cuts *are expected in 1982* due to an approved budget level lower than proposed by the MBTA." (page 12)	• The federal Section 5 operating assistance is scheduled to be phased out over the next three years. In order to maintain the current level of service, additional funding must be generated from existing or potential sources. This is also changed in the text.
5. "It is likely that increased fare box revenue would	

be put towards making up this difference (in loss of federal funds). (page 34)

D. Absence of Comprehensive, Original Work or Findings

The incompleteness and bias of the material in this report is compounded further by the general lack of continuity and sparseness of analysis and interpretation of data, facts, and trends.

The report could be described at this preliminary stage as being an accumulation of facts, trends, data, and oft-heard MBTA positions. The major continuity in this accumulation is its use to bolster the status quo of MBTA procedures. Yet MEPA states that "An EIR should not be used to justify or support a decision that has already been made."

Data on gasoline prices, efficiency changes, trends in cost per passenger and per mile, MBTA costs per mile vs. those of other cities, load factors, number of buses, and similar other details are gathered, but seldom are independent interpretations made or links between data drawn or analyzed.

III. ENVIRONMENTAL IMPACTS

The discussion of air quality impacts of the ridership loss is seriously deficient. Unless this section is significantly rewritten and recalculated, the final environmental impact report will contain almost no analysis of environmental impacts. The current presentation is so incomplete that no comments can be

- Corrected in text.

made on the magnitude, importance, or mitigation of air quality impacts. A particularly severe problem is that all of the analysis is based on a fixed estimate of ridership loss which, as noted above, has not yet been justified. Subsequent reports should at least roughly recalculate impacts for higher and lower ridership loss estimates.

A. Incomplete Information

The environmental impact section of the preliminary draft EIR essentially summarizes the descriptions and calculations in Appendix F, which is itself incomplete. The first few items noted below must be included in the EIR to put the discussion of air quality impacts into context by describing the existing environment and regulatory system. The remaining omissions must be corrected in order to allow interested third parties to replicate the MBTA's calculations if they so desire. For the carbon monoxide hot spot analysis, which may be too complicated to reproduce, appropriate listings of assumptions, worksheets, and/or sample calculations should be presented.

The following information was not included in the preliminary draft:

1. No data is given on historical, current, and projected ambient levels of hydrocarbons (HC), carbon monoxide (CO), and nitrogen oxides (NOx) in the region of interest.

2. No data is given on emission of these pollutants by both mobile and stationary sources in the region of interest.

- The text has been expanded slightly. However, for an example of the CO Hot Spot worksheet used, see Tables 3-2, 3-3, 3-4 in the CTPS report "Identifying CO Hot Spots," July 1981.

- See Section 4.2.5. and the new Appendix F-1. For further detail, see the Mass. 1982 State Implementation Plan for Ozone and Carbon Monoxide, Chapter 2.

- See Appendix F-1.

3. No information on ambient levels of other criteria pollutants is given although such data is pertinent for later consideration of synergistic health effects.	• See Appendix F-1. Ambient levels are not given for lead. These have not been uniformly monitored in the state.
4. No description of the appropriate portions of the Transportation Element of the State Implementation Plan (TESIP), including the requirement for Reasonable Further Progress (RFP), is given.	• Now contained in Chapter 4.2.5 .
5. No listing of pertinent state and federal air quality standards and guidelines is given.	• See Appendix F-1 and U. S. EPA/DOT "Transportation Planning Guidelines," 1978, as amended. These guidelines were incorporated into the state's 3C planning process, as described in Chapter 4 of the 1983 TE/SIP.
6. No background data is given on trip purposes, trip lengths, and automobile ownership used to assign diverted trips to alternate transportation modes (p. F-1).	• Background information came from the sources listed in Appendix F-2.
7. Only incomplete data is presented on average trip lengths for all areas of origin, for students vs. other tripmakers, and for core vs. other destinations (p. F-4).	• See Appendix F-2 for a summary of trip length assumptions.
8. No listing of emissions factors used to convert VMT into emissions in tons/year is given, either in the form of individual factors at given speeds or appropriated weighted averages for different types of trip (p. F-13).	• A-8: A sample of the MOBILE II emission factors have been placed in Appendix F-6. These values include various combinations of temperature, speed, and cold/hot/hot stabilized operating procedure.
9. No emissions factors or adjustments were given for different vehicle operating modes (p. F-13).	• A-9: The air quality analysis was not carried out at this level of detail. Emission rates associated with differing vehicle operating modes have been incorporated into the Mobile II factors.
10. No worksheets, analagous to those given in the queueing calculation, were included for the VMT and emissions calculation.	• The text has been expanded slightly. However, for an example of the CO Hot Spot worksheet used, see Tables 3-2, 3-3, 3-4 in the CTPS report "Identifying CO Hot Spots" July 1981.
11. No quantitative assumptions or calculations were presented in the description of the CO hot spot analysis (p. F-14).	

12. No conversion of increased emissions to increased ambient levels was performed.

B. Poorly Explained Methodology and Assumptions

Providing all the information listed above would still not allow an interested third party to reproduce the MBTA's analysis. The preliminary draft gives an incomplete description of the methodology used to calculate air quality impacts. Given the uncertainty surrounding some of the most important inputs - such as ridership loss - this methodology is a more important planning tool than its quantitative outputs. The uncertainty about some of the assumptions also dictates that each assumption used in the analysis be documented and justified:

1. What is the justification for skewing trip allocations toward downtown and core trips? Was any empirical evidence used in making the assumption that a higher percentage of short trips will be made?

2. How was percent of total trips converted into percent of lost trips? (Table F-1) Apparently the percent of downtown trips was doubled and the percent of core trips was held constant. If this was done, how were the remaining trips allocated?

3. What is the basis for the assumptions about diversions to other modes? (Table F-2) Were these figures calculated or estimated?

4. The data at the top of the fourth page of Appendix F cannot be calculated simply by applying the factors in Table 2

- A-12: A substantial modeling effort, involving the Transportation Air Shed Simulation Model (TASSIM), would be required for this conversion. This computerized model is capable of simulating concentrations of five primary pollutants resulting from mobile and stationary sources. Such a modeling effort would require extensive staff time and was considered an unnecessary level of detail for this report.

- B-1: The demand for short transit trips appears to be more elastic than is the demand for long trips with respect to fare. The London Transport Review Board's 1968 mathematical analysis shows that bus trips of less than one mile exhibit higher elasticities (-.55) than trips of 1-3 miles (-.29). In Essen, Germany, fare elasticities for short- and long-distance trips were found to be -.32 and -.12, respectively. Source: Transportation Research Board, "Transit Fare Policies," p. 44-45.

- B-2: Two assumptions were made in converting the total trip percentage distribution to the lost trip percentage distribution. First, that the lost trip distribution would be skewed toward the downtown and core areas, due to the difference between long- and short-distance fare elasticities. Second, that the percentages of lost trips for the surrounding corridors would be reduced by a constant factor to compensate for the shift in trip distribution.

- B-3: Diverted trips for each corridor were assigned to competing modes or combinations based on relative accessibility, time, and cost. The distribution among modes is the result of professional judgment based on data for existing commuter rail and private bus service, auto ownership, trip purpose, and trip length.

- Corrections have been made to this table.

to the trips in Table 1. When and how was rounding performed? Obvious errors, such as the number of core taxi trips, should be corrected.

5. How was the calculation of VMT adjusted to account for students? How were home-based work trip lengths adjusted to account for core and downtown trip lengths?	• B-5: 15 percent of all diverted trips were classified as children/student trips. The VMT for these trips were calculated separately using an average trip length of 3 miles.
6. How were core trips allocated among cities in the calculation of assigned automobile routes? (p. F-8)	• See Appendix F-2 for table on distribution.
7. Why is there a discrepancy between the number of trips from each area of origin at the top of the fourth page of Appendix F and the number allocated in section F-3, Table 1?	• B-7: The auto trips from each corridor are not simply person trips divided by two. This is because three sets of ridership loss estimates had been presented over the course of analysis and rounding error arose from adjusting each time. In any case, the estimates of trips diverted is higher and so a worst-case scenario is presented.
8. What is the basis for the assumptions about diverting cars from Storrow Drive and the Southeast Expressway? (p. F-8)	• Assumed that diversions would behave similarly to current conditions.
9. What is AWDT and how is it calculated?	• B-9: Average Weekday Traffic Volume; data used was from the Queuing Analysis in the Central Artery O/D Study, CTPS, 1977.
10. A more explicit and quantitative description of the methodology used in the CO hot spot analysis should be presented.	• Has been included in greater detail.
11. Give the source, year, and justification for selecting the following data assumptions:	
a) Automobile occupancies of 2.3 and 1.6 for peak and off-peak (p. F-4)	• The estimate was used in " An Analysis of R.A.C.M.'s to improve Air Quality", C.T.P.S., July 1981 and itself came from a series of E.O.T.C. Memoranda on Ride-sharing.
b) Hourly highway capacities (p. F-9)	• Derived from TRB Circular No. 212, "Interim Materials on Highway Capacity."
c) Base case traffic volumes (p. F-9)	• AWDT came from the 1977 Central Artery O/D Study, CTPS.
d) Background CO concentration of 3.0 ppm (p. F-14)	• DEQE furnished this information.

C. Absence of Conclusions and Mitigation Measures

The preliminary draft EIR makes no attempt to interpret

the results of the air quality analysis or to relate the calculated increases to implementation of the TESIP. The document contains no discussion of the health and environmental impacts of the increased emissions nor does it seriously assess air pollution mitigation schemes. In short, the preliminary draft does not carry the environmental impact analysis to any useful conclusion. The following changes and additions must be made to correct these inadequacies: 1. Summarize current information on the health and welfare effects of the three pollutants of concern.	• C-1: The determination of health effects was not included in the work scope. The EIR analysis was concerned with the effect of additional emissions on Boston's attainment of the Clean Air Act standards. The "Backgrounder on the Clean Air Act" by the House Wednesday Group provides a description of the policy framework and standards of the Clean Air Act. These standards were developed based on the health effect of air pollution. A survey of some of these studies is included in "The Health Costs of Air Pollution" by the American Lung Association, 1977, pp. 73-92.
2. Discuss possible synergistic effects of the three pollutants acting together and in combination with other criteria air pollutants.	• This was beyond the work scope.
3. Explain the MBTA's role in implementing the Boston area public transit portion of the TESIP.	• See the current TE/SIP, Chapter 5.
4. What impact will the three predicted CO violations have on the achievement of Reasonable Further Progress in bringing Boston into attainment?	• Included in Section 4.
5. How were VMT and HC emissions calculated from the fare structure alternatives in Table 5-1?	• See Section 5.3.6.
6. Discuss air pollution mitigation measures which will offset significant percentages of the projected emissions increases. Alternatives should not be restricted to those which the MBTA can implement.	• This is beyond the scope of work.

Draft Environmental and Socioeconomic Impact Report
of the Fare Increase on the MBTA
EOEA #4147
Member of the Study Review Committee - April 21, 1982
General Comments on the Draft by Clark Frazier

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ENVIRONMENTAL AFFAIRS

The document needs a stated policy. If policy has been ennuciated in other certification documents, it should be included and referred to throughout this document. For example, would the policy suggest that decreasing VMT is a goal? There is not the sense that permanently declining ridership is bad. This document also needs an overall policy framework. There is no particular reference to stated growth policy objectives which include focusing economic growth in existing business/commerical areas. Instead, the report assumes a continuing downward spiral; dispersion of population and business (without much growth) continuing decline in T ridership & service. Simply stated; the actions that the EIR is reviewing would cause the effects listed under "assumptions". On the other hand, the City of Boston is projecting a 30% growth in downtown square footage. No similiar increases to the road system or parking are projected. In fact, commercial parking is "frozen: at 1975 levels.

Redevelopment and now population growth of downtown neighborhoods is occurring. The rapid rise in real estate values and the very high cost of land and new housing is now forcing population growth "inward" to reclaim existing housing. Past trends of abandenment and disperial are probably at an end. A pattern of concentration at "suburban nodes" is now occurring with attendant traffic congestion.

- The policy section has been rewritten. Specifically regarding VMT, the goal is to minimize the regional trend of rising VMT; references to increasing VMT describe past and present trends.

- A policy framework has been added to the report in the Introduction Section 1.1.1 and Appendix A and includes statements on economic growth.

- The assumption with regard to ridership levels was that current levels would remain constant (if there were no changes in service provided or major changes such as the price of gasoline).

- Background assumptions about population distribution are based on the Metropolitan Planning Council's forecasts of population and employment. These forecasts support the contention that the City of Boston will experience employment growth and population stabilization in the coming years.

Why is the T investing in extensions if decline is expected?

A reference was made to the State Implementation Plan (SIP) still being "under revision". Clearly, a major reduction in VMT (and a major increase in transit use or a decrease in trips must occur if clean air objectives are to be met (exclusive automobile users travel 10 times as many mileage per year as exclusive transit users). A person making a permanent mode switch from transit will increase VMT disproportionately to transit.

This study examines changes resulting from this action (which will be small in the short term) but fails to make the connection that the cumulative effect of many of these "small" actions have caused the current state of affairs to be reached. That is, a 50% drop in transit use in 20 years; a major increase in highway use (and cost). Extensions of service just to retain part of a more disperied ridership. Decline of weakened transit oriented neighborhoods.

The fare alternative (see detailed comments) are biased and misleading analyses based on the underlying assumptions (which are not stated anywhere) that any rider oriented fare system would be "too hard to administer". Also ignored consistently are operating cost savings that various fare options could produce.

The last problem is that the various mitigating programs listed were mostly "under consideration" or "proposed" or "under development" with not particular sense of deadlines or projected completion dates.

The Ⓣ is of strategic importance to the City of Boston and to the Region and State economy as a result. This report should suggest

- Through system extensions, the MBTA looks to increase its service area and be able to draw from a larger market, thus increasing ridership and addressing the congestion problems at suburban node points.

- According to the 1983 update of the SIP and the Transportation Element of the SIP, with the implementation of those Reasonably Available Control Measures (RACMs) likely to be carried out, the region will be in compliance with the 1987 air quality standards. Additional reductions beyond those required by the Clean Air Act will provide an economic growth cushion for the region. The projected additional VMT of .5 percent resulting from the fare increase will have an effect on this cushion.

- The purpose of the EIR was to look particularly at this one action and not the collective effects of other events, which have occurred unrelated to fare changes.

- This section (Chapter 5 Section 3) has been revised.

- Chapter on Mitigating Measures has been rewritten and their status has been clarified. The MBTA has provided specific information on its level of commitment to a variety of projects.

ways that the political or administrative process could respond to to the needs raised in the report and develop programs that would adhere to existing goals rather than undermine them. If the fare increase and its effect action is consistent with current policy then those policies should be articulated and documented for all to see.	• See the new sections on MBTA policy in the Introduction and in Appendix A.

Detailed Comments on the Draft EIR - April 21, 1982	
(2.4) Ridership Trends and (2.5)Fare levels on the MBTA A large drop in ridership occurred when the free transfer was abolished. The Ⓣ fare structure appears to minimize both ridership and revenue. p. 13, p. 20, Table 2-5	• This is true.
"1977 Transit Market Study" April, 1977 was produced by EOTC and CTPS p. 16 Two cases exist: 1) concessionary fares for elderly, handicapped, students; 2) The pass program designed to reduce fare collection costs and increase off peak ridership. p. 25	• Studies of fare structures among transit properties indicate that, although it might be somewhat modified, the MBTA maintains a common type of fare structure. In other properties studied, fare increases nearly always brought about revenue increases. However, ridership is found to be more sensitive to changes in service than to changes in fare.
2.6 Cost of MBTA Service Ⓣ costs have risen faster than inflation. What are the cost components? What is the % funding by fares after the increase? p. 27	• This report contains a breakdown of the actual MBTA costs for 1978 through 1981, as well as projected figures for 1982.
Section 3.0 Ridership Impact of Recent Fare Increases 1. The impact is difficult to measure because of built in inequities to the present fare structure.	
2. Lack of a free transfer forces the single ride fare to be somewhat too low and the combination fare to be too high. In effect combination riders (who must also change vehicles) are discouraged by high fares and single mode riders often pay less than the fare would be if free transfers were issued. Thus ridership and revenue are both minimized.	• See the section on Transfer Policy 5.3.4.
3. Riders may change destinations; particularly for shopping. This hurts downtown Boston and Back Bay .	

4. The reason that linked trips show the "same" elasticity as unlinked trips is that linked trip data is derived from unlinked trip data. p. 45	• Linked trip data was created from unlinked trip data by applying factors developed during the Wilbur-Smith (1978) Ridership Survey. This is the most recent source of information and its results were used to derive linked trips.
4.0 Environmental Impacts The assumption that trips can switch mode is questionable. Downtown street capacity is limited. Therefore a decrease in MBTA ridership both diverts trips away from downtown (generally increasing trip length) or additionally increases congestion of downtown streets (if that is possible). The expressway and street system in and near downtown are already at capacity. A few additional vehicles will increase delay times disproportionally for everyone. This additional delay time needs to be quantified.	• An assumption was made that a portion of transit trips could, in fact, divert to automobile travel. This is evident during unusual situations, i.e., strike days that some additional modal switching is possible, though undesirable. • See Appendix F-2 Queuing Analysis has been conducted to study this phenomenon.
The seriousness of the CO problem is underestimated. There is no justification for making a situation worse because it is bad already. pgs. 56-57	• Section 4.2.3 Carbon Monoxide Increases: Intersection Impacts has been rewritten.
The assumption that trips diverted from transit will stay the same length is false. Divirted trips to other destination may be longer. Therefore the increased VMT is underestimated.	• No assumption that diverted trips maintain the same trip length has occurred. Independent trip lengths were developed based on those cited in the TE/SIP.
5.0 Alternatives 5.1 The MBTA could have cut administrative overhead and other unnecessary supervisory persons before cutting service but chose not to. pgs. 60, 62	• See Management Practices Study, Section II: Evaluation of Staff and Budget Levels and Appendix A: Comparison of Staffing and Expenditure Levels and the Organizational Structure of Four Departments with Other Systems.
The costs that the Ⓣ incurs need to be summarized into a few categories and quantified.	• This information is available in the MBTA Budget 1983/FY 1984, page 14.
5.2 Peak Period Pricing The point of peak period pricing is to reduce costs by reducing the peak equipment and manpower requirements. This may increase the peak highway capacity needs, however.	• For particularly that reason, it is thought that the negative effects of peak-period pricing would outweigh the benefits.

5.3.3 Self Service Fare Collection

This section was written from a very negative point of view. Not all of the major benefits are listed. The additional major benefits are reduced cost and improved accessibility (all station entrances can remain open). Security can be improved because the station attendant can walk around through all parts of the station.

The negatives mentioned:

1. Vandalism - also shared by automated systems such as BART, WAMTA

2. High labor cost of ticket selling - this is the current problem with tokens.

3. The idea that Boston residents are not law abiding because of a 15% collection ration on parking tickets should be attributed instead to poor administration.

4. Page 77 - "reduced construction costs of little interest". Extensions are underway where lack of barriers could noticably decrease costs....

Also, 20% of capitol costs end up as "fixed costs". (The state share)

5. A major means of avoiding various fare collection problems is to sell passes to the majority of riders. A self service system does not require pass readers and other barrier equipment. Instead a system of passes (with photo) and validation stickers or stamps can be used.

This and other sections fail to detail what cost savings and other benefits could occur.

5.3.4 Transfers

The current system minimizes ridership and revenue. Single ride fares are artificially low so that the combination fare will not

- Changes have occurred in this section, and improvements suggested have been largely incorporated.

- See Section 5.4.3. for a discussion of self service collection procedures.

be too high. But the combination fare is always perceived to be too high. The current fare policty exists because no one worries about any issues larger than making it through the current bugetary year. The MTA used to use paid busway zones (like Toronto) to eliminate paper at high volume points .

5.3.5 Lower Fares for Downtown Distribution

An alternative not considered would be an all day pass prices at about 2½ full fares or alternatively a lower price pass 1½ fares good only for entry at downtown stations.

Another alternative is a transfer with 2 hour validity (San Francisco has moved to this system). This provides a 50% discount for round trips that can be completed within 2 hours.

The real problem with any type of downtown shuttle system in Boston is the street system.

7.0 Mitigating Measures

This section mainly discusses programs that, if implemented, could help speed service or improve productivity. The problem seems to be there are future plans and continue to remain that way. Signal priority has been discussed for years, using overly sophisticated technology, with the result that very little has been accomplished. The T has not digiligently persued such improvements as signal priority.

Comments from Ann Hershfang Boston - League of Women Voters to Debby Schreiber (and Sam Mygatt, if appropriate) Section 5:3.1 .. (p67) Impact of ..... Elderly - could this be in a chart so that the various ridership figures - 59,000 45,000 27,000 32,000	• Now in Section 5.3.2.
and ~~ser~~ revenues & savings could be easily correlated & understood? Also are these figures based only on "weekdays"? How many days a year?	• The assumptions are explained in Appendix B (base data) and Appendix E (ridership loss estimates) and a revised Section 5.3.1.
(p68) seems to change to another subject in ¶ 2 - and needs a new heading.	• Has been corrected.
5.3.2 (p71) Reduced fare .... Groups. ~~Also~~ The student fare discussion here is about raising not reducing them. The Boston LWV requested that you include an analysis of the possibility of & consequences of providing 1/2 fare rides for children up to 18 at all times, not just school hours. We again request it.	• Now in Section 5.3.2.

Exhibit G: Are these figures available all day, not just peak period? (just curiosity.)	• See the listed source for additional time period information.
pp52-3 – the Arborway line is missing	• This has been included where the data was available.
The League asked for comparative Nov 80 & Nov 81 garage use figures as maintained by various garages and traffic data for major radial highways, Could w as an actual way of determining whether tr. automobile use into the region had increased, May those be included?	• Garage data is available in Section 2. • This material has been included where possible in Appendix F-10.

Comments on the Final Environmental & Socioeconomic Impact Report of the MBTA Fare Increase.

League of Women Voters of Massachusetts
Contact: Anne Fanton, 263-4989

Introduction:

There are substantial additions and improvements to the Revised Draft which are very useful, specifically: the addition of an Overview and a Policy Framework, and improvements to the sections on Service Level Changes, Ridership Impacts, Alternatives and Data Collection. The inclusion of the Scope of Work, Comments received by EOEA on the draft reports, a glossary, bibliography and index also greatly improve the impact report. CTPS responses to comments, noted to the right of each committee comment, were especially useful.

Of great concern, however, is the omission of the comments by the Sierra Club and the Conservation Law Foundation (CLF), both of which contained detailed, thoughtful recommendations for improving the entire draft report but most specifically the Environmental Impact section (4). Their comments were submitted to EOEA on April 21, 1982. Since apparently CTPS did not have these comments when preparing the final report, there is no response to them, nor any improvement to Section 4, with the exception of adding Section 4.2.4, Atmospheric Lead Level Impacts, as requested by EOEA. The League believes that the concerns of the Sierra Club and CLF have not been adequately addressed in the final report. We ask that you read their comments again and consider, for example, whether the environmental impact analysis is carried to any useful conclusion. In some instances, they may be asking for analyses that go beyond the Scope of Work, and that should have been called for at that time, but they do express well our shared concern that the EIR/SEIR breaks little new ground, and does not go far enough to be useful to future decision-makers considering fare increases and service reductions.

Detailed Comments:

1.) It was my understanding (AF) that Section VI (MBTA Expectations) of the Scope of Work would draw together the various sections of the report into final conclusions and recommendations. It stands instead as an isolated statement of existing MBTA policy. Whether this was just a misunderstanding during Study Review Committee discussions regarding the Scope of Work is probably not worth pursuing, but somewhere, probably at the beginning of the report, a summary of findings, conclusions and recommendations for each section and the report as a whole is very necessary if it is to be useful, especially since most readers will read just the summary. Also, thereason that so many committee members requested a policy framework was so that recommendations would aim to carry out stated policy. This has not been done.

2.) 1.1 Overview, p.1
The League recommends that this section be expanded as described above, that it include a summary of Section 5, Alternatives and more detail on Socioeconomic Impacts and Mitigating Measures. The summary of mitigating measures (p.5) implies that the MBTA is already taking the necessary steps to mitigate the impacts of fare increases and service reductions. In fact,

- These have been added and response to comments included.

- The MBTA policy framework is now summarized in Section 1 and explained in more detail in Appendix A. Also included is a summary of relevant portions of the regional transportation policy.

- This has been done. The Summary section now includes this other information in a table form. Section 7 contains schedules for mitigating measures.

there are several recommendations for further action, on pp. 119-128, which should be highlighted in the Overview. We feel that the Overview should highlight all important conclusions of each section and state the recommendations.	• The summary has been adjusted to address these points.
3.) 2.4.1, Recent Service Level Changes, p.27 This section is much improved. 2.7.2 still lacks independent conclusions necessary to making this entire analysis useful.	
4.) 3.0, Ridership Impacts, p.55 The addition of information on other cities is excellent and the entire section has been clarified. In the Overview, section 3.0 should emphasize above all the need for an accurate method of counting riders.	• This is stressed in several places in the revised draft.
5.) 5.0 Alternatives, p.77 The League feels this section will be very useful to the MBTA as a first step towards a creative, equitable fare structure. Its highlights should definitely be included in the Overview section.	• They have been included in the detailed summary.
6.) 6.0 Socioeconomic Impacts, p.95 Also useful as a first step; it still lacks a clear recommendation for improving the MBTA's data collection. Where is the "MBTA technical memo"? (see p.164.)	• The memo referred to is CTPS Technical Report No. 39,"1981 MBTA Fare-Mix Sampling Program: Analysis and Documentation," which contains details of the data collection effort.
7.) 7.0 Mitigating Measures, p.119 The major mitigating measures, promised by the MBTA in return for the fare increase (ref. EOEA #4147), were service quality improvements and service restoration. There is not enough attention given to service quality improvements (7.1.1) to know whether any came as a result of the fare increase.	• Service quality improvements which were established as mitigating measure of the fare increase, can be found in Section 7.
8.) 7.1.3 Data Collection, p.121 This section is much improved, as is 7.2.2, Alternative Funding Sources.	

The League would like to express its appreciation to Sonia Weinstock of CTPS for many of the improvements mentioned. We hope that the MBTA and EOEA will agree to revise the Overview, as requested, before Secretary John Bewick accepts the final report.

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METROPOLITAN AREA
PLANNING COUNCIL
110 TREMONT ST.
BOSTON, MA 02108
Tel. (617) 451-2770

April 23, 1982

The Honorable John A. Bewick, Secretary
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, Massachusetts 02202

Attention: MEPA Unit

RE: Draft Environmental and Socioeconomic Impact Report--Fare Increase on the MBTA, EOEA #4147 (MAPC #EIR-82-15, Received March 23, 1982)

Dear Secretary Bewick:

In accordance with the provisions of Chapter 30, Section 62 of the Massachusetts General Laws, the Metropolitan Area Planning Council has reviewed the above-referenced Draft Environmental and Socioeconomic Impact Report.

The MAPC staff has participated in the Fare Study Review Committee activities concerning this Environmental and Socioeconomic Impact Report and the MBTA Management Practices Study. Because of the size of the draft EIR and the cost of reproducing and mailing it, MAPC staff developed a four-page summary which was distributed to the 101 MAPC communities which include all 79 MBTA member cities and towns. The covering letter to the summary invited individuals into the MAPC offices to review the complete document if they wished or to contact MAPC staff. A total of 33 communities replied to the summary. The following is a summary of their comments.

- Lexington supports a well managed transportation system as a way to meet environmental concerns and provide transportation in an economical way to all concerned. We support a capping of MBTA assessments to municipalities.

- Would hope that reduced fares will not reduce service.

- Use of "citizen groups" to increase ridership. Do not close stations after 7 p.m. or on Sundays. We are living with the fare increase so it doesn't seem much can be gained with a decreased fare. Environmental impact discussed earlier at J.R.T.C. and I feel there is an adverse effect with increased automobiles in city. Cohasset does not directly have MBTA service and the community would like.

- I strongly oppose a fare increase on the basis of environmental and budget concerns.

eth A. Bransfield, president William C. Sawyer, vice-president Richard M. Doherty, secretary Patricia A. Brady, treasure

Executive Director Donald E. Megathlin Jr.

- The MBTA appears to be addressing their current problems as intelligentl as possible. However, consideration should be given to lowering the far and the parking lot charges, especially at Riverside, in an attempt to regain riders.

- Any increase in fares' effect on air quality or vehicular congestion is speculative and questionable. There is reason to believe, that lost ridership simply reduces total travel. Full fare paying potential users don't require 100% reliability; what they require is comfort. Diddling with the system is counter productive, an aggressive implementation of Chapter 581 is needed for this featherbedded-ridden system.

- Emphasis should be placed on improvements in operating efficiency and reduction of costs rather than increases in fares.

- Bus service for local and regional public and private schools should be abolished. The decision to grant free passes to the elderly should be revoked. Lines which do not provide an adequate cost/revenue relationsh should be identified. Then, the fare decrease should be implemented. T study is flawed because it has allowed the (T) Board to move in directio which seem to be politically based.

- Some new items to consider: (1) threat of new and reduced restrictions relation to car emissions to be instituted on federal level; (2) the imp of the recent and strictly-enforced parking regulations in Boston; and (3) what will be the impact of the newly voted fare decrease.

- It is patently unfair to base reduced rider T-fares on increased appropr from the cities and towns. The citizens of Hanover pay 100% of their ow transportation costs. Cutting the fares adds to the burden upon them.

- Need more detailed info on ridership by mode, bus, LRV, rapid transit.

- Are public hearings on this proposal be to held? When? Very concerned over proposed cuts in service, particularly in commuter rail (Page 3, Implemented Action), being included with a fare increase. What is the intent? How do the new "management rights" provisions affect fiscal operations (i.e., fares, reduced service, needed maintenance, etc.).

- The Town of Hamilton is not in favor of further fare increases.

- None of the above. Cutting service is insanity.

- There is no problem with the report but we question the impact of the increase in light of the proposed decrease for the (T). An impact stud should be done.

The MAPC staff has previously expressed its concern for the impact of far changes required as a result of the agreement between General Manager O'Leary and Secretary Bewick. It is highly likely that fare reductions will increase deficits and therefore require increased public funding or reductions in servi

In addition there is a concern that the MBTA has not been collecting sufficient ridership data by mode and route, along with other related data which can be used in analyzing the system. Data, such as level of service by mode and route and ridership by the mode, routes and time of day are not related to other factors such as operating costs and dependability. However the MAPC understands that the MBTA is in the process of improving their data collection procedures.

Very truly yours,

Donald E. Megathlin, Jr.
Executive Director

cc: Mr. Richard Easler, Chairman
Transportation TAC
Mr. Rocco Mancini
Massachusetts Bay Transportation Authority

APPENDIX A-5

SERVICE PLANNING: DESCRIPTION AND DATA BASES

SERVICE EVALUATION

This section presents the general framework within which the MBTA makes decisions for service changes based upon the service policy for surface transportation and the existing MBTA data base. This set of information is used by the Service Planning section to draw upon for implementing service changes, as explained below.

1. Description

Service planning has been the responsibility of the Service Planning section within the Operations Directorate. The Service Planning office is the major actor in implementing service changes consistent with the Service Policy. The Operations Planning and Schedules departments are also under the Operations Directorate and they are involved in the service assessment process. The process takes place on three levels as described below.

a. Route Configuration

The focal unit of service planning for introducing changes to the structure of routes--new routes, route extensions, route deviations, thru-routings, major changes in headways and hours of service--is the Service Committee, chaired by the Manager of Service Planning. Other members of the committee include representatives of:

- Service Planning
- Operations Planning
- Schedules
- Transportation
- Community Affairs and Marketing

In addition, there are several non-voting members who attend meetings as appropriate to agenda items. The managers of the Transportation division also have a strong influence on the decision of the Director of Operations.

b. Level of Service

The process explained above usually is initiated upon request from sources outside the MBTA for major changes in level of service; however, emergency conditions may require service changes initiated by the MBTA itself. The procedure of making minor adjustments to headways, trip times, numbers of scheduled trips, or responding to most internal requests for changes is handled more simply by the Service Planning or Scheduling sections. They rely on peak-load point counts and on-board characteristics counts, in order to study the recommended adjustment. Subsequently, the proposed changes can be approved directly by the Operations Director.

c. Route Viability

Another level of assessment practiced at the MBTA relates to the elimination of service which is no longer found to be ecomonically viable. Initially, revenue data, reported for each route on a quarterly basis, is used as a preliminary indicator in the ranking of routes. Routes of unsatisfactory revenue performance are subsequently ranked for the following measures:

- average operating speed
- average schedule speed
- labor productivity by route and garage
- complaints

Next, routes identified as being substandard are given a thorough review, using characteristic counts and on-board survey data. On the basis of this review, a decision is made either to initiate remedial action to improve performance, or to discontinue the service.

2. Service Policy for Surface Transportation

The MBTA was among the pioneer transit authorities in the U.S. to adopt service standards for bus service evaluation. They were endorsed by the Advisory Board in December 1975 and revised in 1977. The general statement of the purpose of the Service Standards is stated in Section 1.2 of the document:

> "Purpose
>
> General Statement
>
> Establish a system of management policy that is prudent, effective, and responsive for use in guiding the operation and improvement of surface transit services within the MBTA district.
>
> a. Provide a uniform and effective basis for evaluating the relative costs, benefits, and overall performance of individual services.
>
> b. Provide a responsive and effective methodology for establishing new services and improvements to existing services.
>
> c. Provide a consistent basis for determining the operating responsibility for individual services and supplemental financing arrangements for 'substandard' services."

In the remainder of this section, a list of the current standards and guidelines is provided. They are contained in three groups according to the function they serve:

- Service Design Guidelines
- Operating Performance Standards
- Economic/Social/Environmental Standards

a. Service Design Guidelines

- spatial guidelines
- directness of service
- route layout
- frequency of service
- temporal guidelines
- passenger stops
- passenger shelters
- market potential

b. Operating Performance Standards

- speed
- recovery time
- load factors
- labor productivity
- schedule adherence
- service dependability
- complaints

c. Economic/Social/Environmental Standards

- revenue to cost ratio
- passengers per hour
- passengers per mile
- transit dependency
- elderly and handicapped dependency

3. Data Resources

This section discusses the current bus service information collected by the MBTA. Data providing insights to the market served by the bus network is collected on an individual route basis. Data concerning bus operations, such as missed trips or disabled vehicles, are compiled by the specific garages.

a. Scheduled Trips by Route

This file includes the schedule times for each bus trip, the time it leaves the terminal, arrives at its destination, leaves its destination, and arrives back at the terminal. The information is used to develop reports on schedule operating speed and scheduled route miles. It serves as a basis for the service performance report, for allocating costs, and for town assessments.

b. Route Profiles

The route profiles contain information on route mileage and mileage by town. This data is updated whenever a route is changed in any way. The route profiles also serve as the main source for allocating mileage for town assessments.

c. Route Cost Data

Costs incurred in bus route operations are allocated to bus routes based on scheduled trips derived from the schedule trip file. Cost data is utilized to compute revenue to cost ratios and to determine the costs allocated to towns within the MBTA district.

d. Route Revenue Data

Revenue data is collected and recorded daily by the MBTA's six rating stations. Allocation of revenue to each bus route is calculated based on factors reflecting the percentage of the rating station collections from each route. The factors are computed during a oneweek revenue reading period per quarter, when operators record the farebox readings every time they change routes. Then, assuming stability of these factors over the three-month period, they are applied to all other weeks during the quarter. These quarterly summaries are used to calculate economic performance measures, such as revenue to cost ratios, revenue per mile, revenue per hour, revenue per passenger and town assessments.

e. Traffic Checker Counts

Traffic checkers perform three types of counts: peak-load point counts, characteristic counts, and specialized route segment counts. All counts provide the MBTA Plans and Schedules Department with route specific data on ridership by time of day. However, the level of detail varies between the types of counts. A description of each type of count follows:

- Peak-load point counts are performed once a rating period for each route. These are not stored on computer file. The traffic checker stands at the peak-load points and records the date, weather, location of count, the time, vehicle number, and number of passengers on board for every bus passing that point. The counts are then summarized by time period, and by intervals within the time period. Total ridership per time period is divided by number of vehicles per time period to determine average loading.

- Characteristic counts are performed on request from various departments in the Authority. As a result, current profiles are not available for most routes. These are also not stored on computer file. The traffic checker rides the bus and records date, weather, scheduled time it leaves, actual time it leaves, passenger boardings and alightings, and time it arrives. The counts are summarized manually to provide total passengers on board, time leave, time arrive, and elapsed time of trip.

- Specialized counts are designed to provide data for specific purposes and they are summarized as needed by the department requesting the information.

All summaries are used by the Schedules and Service Planning Departments. The Schedules Department uses the information to make minor changes in the schedules. Service Planning uses the information to evaluate route change proposals, service changes, and new routes. Information derived manually from traffic checker counts include passengers/mile, passengers/hour, average fare, passengers/trip, and ridership by route segment. Although it has not been done previously, the traffic counts could also be used to provide statistics on schedule adherence and the number of standees.

f. Bus Stop Location File

This is a computer file which contains the location (nearest street intersection), length, and town location of all bus stops, and distance between them. The distance information is used to calculate bus passenger miles, a requirement for Section 15 of the 1979 Surface Transportation Act.

g. Garage Operation Forms

A variety of forms are used for management control in the Transportation Division.

- The Motor Bus Operation Form or Bus Pullout Assignment Sheet is used for bus assignment. The form contains information on operator name, bus number, time pullout, route number, run number, time put up. It is also used to note when a bus is not available for a scheduled trip, or how many trips are missed if the bus is dispatched late.

- The Daily Report of Defects provides data on vehicle number, route number, operator number, time defect occurred, whether passengers were unloaded or shifted to another bus, the length of the delay, and the description of the defect. From this report, it can also be determined if any trips were missed due to a disabled bus, and which route was affected.

- The Assignment Block form is used to record daily manpower coverage of scheduled runs or any portion, as well as the assignment of additional trips.

- A Variation from Schedules form is used to record any variation due to late departures or missed or added trips. The date and the operator, route, trip time, and reason for each variation are also recorded.

- The Daily Lost Trips form summarizes lost trips by run number, trip time, route number, number of trips affected, operator number, and the reason for the loss. The garage sends the completed form daily to the Revenue Department. The Revenue Department uses the information to make corrections in revenue miles operated for town assessment purposes.

h. Daily Service Report

This report contains information compiled from the garages on the number of trips run, missed, or added the previous day. It also records the number of buses not available in each garage.

i. Consumer Commendation/Complaints File

Commendations and complaints are recorded by telephone operators on forms which include information on route, time of day, type of complaint, and date of complaint. The forms are manually summarized and used only by the Public Affairs and Information Department.

4. Critique of Bus Evaluation Process

This section of the report addresses the weaknesses of the current MBTA evaluation program. These problem areas were identified from the completion of the review of the procedures, standards, and data resources in the previous sections.

a. Service Planning and Evaluation Procedures

The review reveals that, although detailed guidelines currently exist for the analysis and assessment of existing services and new proposals, these procedures are being only partially followed. Generally, evaluation is only exercised, upon special request, on new proposals and route rankings. Systematic analysis of existing services on a route-by-route basis is nonexistent. Constraints on the time available to MBTA personnel involved in the process and lack of recent valid data appear to be the major reasons. The monitoring of passenger loads is one procedure in use on a continuous basis, but it is not rigorously documented.

b. Service Standards and Guidelines

For the most part, service standards and guidelines are judged to be sufficient, if supported by adequate data and utilized systematically, and could cover the assessment of a variety of situations. However, current utilization of standards is mainly restricted to service design and to those standards on operating performance which have a direct impact on the service as perceived by the riding passenger: headways, speed, load factors, schedule adherence, service dependability, and complaints. These standards are used quite actively, because they are comprehensive, easy to apply, and utilize readily available data.

On the other hand, efficiency standards, such as recovery time and labor productivity, which are extremely important to monitor for management cost control, have not realized wide utilization. Revenue to direct cost rating, passengers per hour, and passengers per mile are used for the assessments of economic performance of routes, but these standards have experienced associated data problems.

In summary, application of standards is biased towards effectiveness of service, while supply evaluation is neglected. Sole reliance on effectiveness measures does not lead to improvements since these measures are mostly useful in identifying the problems and not their causes.

APPENDIX A-6 -- SUMMARY OF STUDIES AND LEGISLATIVE PROPOSALS INITIATED TO IMPROVE THE MBTA

Over the past decade, several committees and task forces have been organized to investigate and make recommendations on ways to improve the MBTA. The MBTA's management structure has been reorganized through State Legislation twice during this period, first in 1973 and again in 1980. A review of the changes in the organizational structure and the outcome of these task force studies are presented in this section. Also included is a compilation of all legislation filed in the State Legislature between 1973 and 1982. Although none of the bills in the listing were enacted, this compilation serves to show the types and volume of the proposals which have been brought before the State Legislature for review.

The problems confronting the MBTA today are basically the same as those discussed ten years ago--declining ridership and service levels, less than optimal productivity and efficiency levels, increasing cost of service, and taxpayer complaints about higher taxes. A task force formed by Governor Sargent in 1970 to investigate transportation policies and programs in the state offered several reasons for the MBTA's problems. The task force pointed to a long history of a deficit operation and a preoccupation with capital expansion. They found a general neglect of preventive maintenance and modernization over the previous years. The MBTA's union work rules, politics, and lack of contract work were also noted as contributing to the problems. Recommendations of the Governor's task force included ways to improve efficiency and reduce the deficit. A proposal to set-up a state tax fund for transit was made. The task force further suggested that the unions and management work together, and proposed a stronger management structure centered at EOTC.

During this same time, a special commission was set-up initially under Chapter 126 of the Resolves of 1967 and continued through 1970 under Chapter 3 of the Resolves of 1970. The commission was formed to "make an investigation and study relative to the finances and operation of the MBTA". They made six reports to the State Legislature during this time period, addressing such issues as the MBTA's capital expansion program, its financial management and its legal structure. The commission's work proceeded under several governing principles among which were the following:

1) That an increase in the level and extent of public transportation in Boston is essential to the continued availability and growth of downtown Boston;

2) that any system be sufficiently attractive to induce auto commuters to switch to transit;

3) that major improvements be made on rail; and

4) that the cost of service be charged as fairly as possible to those receiving the benefits.

The special commission came to several conclusions and proposed recommendations on the basis of several hearings, special task force reports, and consultant reports over the four years. In addition to assigning priorities to capital improvement programs and recommending methods to improve the allocation of the net cost of local service, the commission proposed a reorganization of the management structure of the MBTA. They concluded that the law that set-up the authority allowed for inefficiencies in providing service to the communities, although they concluded the MBTA had provided a net benefit to the area. The commission suggested that the power in the authority be concentrated in one individual, a commissioner, appointed by the Governor. It also proposed abolishing the Board of Directors and the General Manager's position. Another commission was set-up by Governor Sargent in August 1972 to propose specific changes in the organization, administration, and finances of the MBTA.

In 1973, Governor Sargent filed legislation to reorganize EOTC and the MBTA. The purposes were to increase the executive authority and accountability at the MBTA; to enable the Advisory Board and General Court to control costs more effectively; and to facilitate comprehensive transportation planning. Chapter 1140 of the Acts of 1973 provided for some changes in the administration and management, which included combining the positions of Chairman and Chief Executive Officer, although the MBTA was still under the direction of a five-member Board of Directors. In 1974, the funding system was changed such that the state provided 50 percent of the MBTA's net deficit and the Federal Government provided operating assistance as authorized under the Urban Mass Transportation Act of 1974. The reorganization took effect in January 1, 1975.

By the end of 1976, the reorganization was viewed as a success and seemed to be alleviating some of the MBTA's problems. There were still some concerns expressed specifically by the Advisory Board about the distribution of the state's share of deficit to express service, about inequities in the local assessment formula, and about the dependence upon the local property tax to cover the local share of the MBTA's deficit. As a solution to the local financial burden on the property tax, the Advisory Board recommended using revenue from an increased sales tax, a broader based sales tax, a tax on gasoline, or a regional payroll tax.

The late 70's saw increasing costs and a greater burden of those costs on taxpayers, although ridership was increasing. Financial problems were evident throughout this system and once again in 1980, the Governor and the Secretary of Transportation appointed a task force to make recommendations for improving the Authority's performance. They looked at both short-term solutions to the financial problem of 1980 and long-term solutions that would develop a funding mechanism and management structure to avoid future financial crises. The task force proposed changes in the managerial structure of the MBTA, changes in their funding sources (motor fuels tax, toll tax, parking tax), assessment policies and fares (increase rapid transit by 25 cents), revisions to the financial planning and cost accounting methods, as well as changes to the labor/management relationship. They proposed that legislation be drafted that would give the "T" the authority it needs to make changes to improve service, reduce the burden on the property tax, and reverse the negative public perception of the MBTA.

Following a one-day shutdown on the MBTA in December 1980 due to depleted operating funds, the State Legislature passed an emergency bill to allocate additional revenue to operate the MBTA through the end of the year and reorganize several aspects of their operations. Major components of this legislation, Chapter 581 of the Acts of 1980, are as follows:

- Re-created a General Manager's position;
- increased the size of the Board of Directors to seven members with the Secretary of Transportation as the Chairman;
- created a position for a Governor's designee on the Advisory Board to have voting power equal to that of the largest member;
- assigned several rights to management covering employment policies, service policies, and productivity standards; and
- placed a 4 percent cap on the operating budget of the MBTA.

In 1981, the MBTA's management started to exercise some of the rights obtained from the 1980 legislation, following a court ruling in their favor over the legality of the law. The benefits of the reorganization will start to materialize in the near future. Some of the work rule changes which came out of this are included in Appendix D. With the ilntent of improving the accountability at the "T", the Massachusetts Taxpayers Foundation, Inc. proposed a reporting system that would directly relate service to cost. Detailed information would be gathered on service, both quantity--riders, hours of operation, and revenue; and quality--reliability, regularity; costs such as wages, expenses, capital; efficiency measures; effectiveness measures; and, comparability to other systems of time periods. Currently, the MBTA is making an effort to obtain better operating data through the institution of an annual ridership survey and the maintenance of base data for future comparison and analysis.

A detailed listing of studies initiated to improve the MBTA follows as a resource for those interested in further study of the issue.

APPENDIX A-6 (cont.)

LISTING OF STUDIES TO IMPROVE THE MBTA

Central Transportation Planning Staff, Technical Report No. 26, MBTA Systemwide Passenger Data Collection Program, Volume 1: Rapid Transit System, April 1981.

Central Transportation Planning Staff, Commuter Rail Improvement Program, 1978.

Commonwealth of Massachusetts, Interim Report of the Special Commission Established to Make an Investigation and Study Relative to the Finances and Operation of the Massachusetts Bay Transportation Authority, March 1970, Senator James R. McIntyre, Chairman.

Commonwealth of Massachusetts, Executive Office of Transportation and Construction, Reorganization Legislation, Phase II, March 1973.

Decision Research Corporation, Dime Time Ridership, Study No. 2, for MBTA, (Wellesley Hills, Massachusetts; Decision Research) June 1974.

Governor's Task Force on Transportation, A. Altshuler, Chairman, Report to Governor Sargent, Part II, June 1970.

Massachusetts Bay Transportation Authority, 1981 Current Expense Budget and Auxiliary Data, Boston, 1981.

Massachusetts Bay Transportation Authority, The Legal Structure and Management of the MBTA, October 1980.

Massachusetts Bay Transportation Authority, Title VI Assessment for Capital and Operating Assistance, December 1981.

Massachusetts Bay Transportation Authority, Bus Service Evaluation Procedures: A Review, 1979

Massachusetts Bay Transportation Authority, Five Year Development Program 1973-1977, 1973

Massachusetts Bay Transportation Authority, Report of the Fare Policy Committee on Fare Structure and Fare Levels, 1980.

Massachusetts Bay Transportation Authority, Service Policy for Surface Public Transportation, 1977.

Massachusetts Bay Transportation Authority, Service Policy for Surface Public Transporatation, 1975.

Massachusetts Bay Transportation Authority, "T" Preventive Maintenance Program for Buses, 1980.

Massachusetts Bay Transportation Authority, Ten Year Transit Development Program 1974-1983, 1974.

Massachusetts Bay Transportation Authority, Transit Information Study, 1971.

Massachusetts Bay Transportation Authority Advisory Board, Labor Costs at the MBTA, 1980.

Massachusetts Bay Transportation Authority Advisory Board, Public Transportation Financing - A Survey of Options for Alternatives to the Property Tax Which Has Hampered Massachusetts Economic Development, Staff Draft, October 1976.

Massachusetts Bay Transportation Authority Advisory Board, Report of the Budget Committee on MBTA Service Performance, Budget Performance, Department Performance, 1975.

Massachusetts Executive Office of Transportation and Construction, Transportation Needs - Transportation Services, Staff Report #1, 1976.

Massachusetts Executive Office of Transportation and Construction, Transportation Technologies: Applicability and Cost Effectiveness, Staff Report #2, 1976.

Massachusetts Executive Office of Transportation and Construction, Capital Needs for the Existing Plant and Vehicle Replacement, Staff Report #3, 1976.

Massachusetts Executive Office of Transportation and Construction, 4A Service Quality and Efficiency, 4B Needs for Elderly and Handicapped, Staff Report #4, 1976.

Massachusetts Executive Office of Transportation and Construction, Capital Needs at the Corridor Level, Staff Report #5, 1976.

Massachusetts Executive Office of Transportation and Construction, Priorities and Budgets, Staff Report #6, 1976.

Massachusetts Executive Office of Transportation and Construction, Management Policies Affecting the Capital Program, Staff Report #7, 1976.

Massachusetts Executive Office of Transportation and Construction, Five Year Transit Development Program, Boston Region 1975-1980, 1975.

Massachusetts Great and General Court, An Act Relative to the Structure of the MBTA (Chapter 581, Acts of 1980).

Massachusetts Great and General Court, Special Commission Relative to the Finances and Operation of the MBTA, 1971.

Massachusetts Governor's Commission to Examine the Financing and Organization of the MBTA, 1972

Massachusetts Legislation Special Commission, Relative to the Finances and Operation of the MBTA, 1969.

Massachusetts Taxpayers Foundation, Inc., What's Missing at the T, 1981.

Palmere, Anthony J., Alternatives for Financing the MBTA, (unpublished thesis), John F. Kennedy School of Government, Harvard University, April 1981.

Transportation Policy Workshop, Department of City and Regional Planning, Harvard University, Evaluation of Alternative Fare Structures for the Massachusetts Bay Transportation Authority Cambridge, Massachusetts, May 1980.

APPENDIX A-7 : Legislation which has been filed from 1973 - 1982 relative to State Aid for the M.B.T.A.

MASSACHUSE
BAY
TRANSPORTAT
AUTHORITY

: Donald Kidston
Development Coordinator

om: James D. Harrington
Legislative Counsel

Date: July 20, 1983

Attached hereto please find lists of legislation filed from 1973 to 1982 relative to state aid for the M.B.T.A. None of these bills was enacted as filed; they merely reflected the interest of various legislators. During this period, the Commonwealth did assume part of the M.B.T.A. net cost of service. This was done through the General Appropriations Act each year (The Budget).

James D. Harrington
Legislative Counsel

JDH:cg

Attachments (10)

1973

S. 1336 - Petition of John W. Bullock, John F. Cusack and Eleanor M. Campobasso for legislation to provide that the Commonwealth assume the entire deficit of the MBTA.

S. 1352 - Petition of Arthur Joseph Lewis, Jr. for legislation to require the Commonwealth to assume all the costs of operation of the MBTA.

S. 1359 - Petition of Denis L. McKenna for legislation to require the Commonwealth to assume all the costs of operation of the MBTA.

S. 1379 - Petition of Mario Umana and another for legislation to provide payment by the Commonwealth of certain costs of mass transportation service in the Commonwealth.

H. 776 - Petition of Richard F. Finnegan that the entire net cost of service of the MBTA be paid by the Commonwealth without assessment to cities and towns.

H. 1155 - Petition of Alan Paul Danovitch that the Commonwealth assume the cost of operation of the MBTA.

H. 1439 - Petition of Francis D. Doris that the Commonwealth pay the entire deficit of the net cost of service of the operations of the MBTA's express service.

H. 2798 - Petition of Thomas F. Brownell that the Commonwealth assume the entire cost of the deficit of the MBTA.

H. 3590 - Petition of Thomas D. Mann, William F. Hogano and others that the Commonwealth be required to assume the cost of operation of the MBTA.

H. 3774 - Petition of Raymond L. Flynn that the Commonwealth assume all the costs of the operation of the MBTA.

H. 3872 - Petition of John F. Melia and Michael J. Daley for legislation to provide that the Commonwealth assume the payment of the annual deficit of the MBTA.

H. 4054 - Petition of James J. Cronin, Jr. that the Commonwealth assume the cost of operation of the MBTA.

H. 4057 - Petition of Kevin H. White and John F. Melia for legislation to provide for payment by the Commonwealth of certain costs of mass transportation services.

H. 4249 - Petition of William J. Dignan that the Commonwealth be required to assume all costs of operation of the MBTA.

H. 4255 - Petition of James E. Smith, John F. Cusack and others that the Commonwealth assume the payment of certain costs of the MBTA.

1973, cont'd.

H. 4448 - Petition of John J. Finnegan for legislation to provide that the Commonwealth assume the payment of the annual deficit of the MBTA.

H. 4829 - Petition of William A. Carey for legislation to provide that the Commonwealth assume the payment of the annual deficit of the MBTA.

H. 4836 - Petition of Clifford H. Marshall that the Commonwealth assume the entire cost of operating the MBTA.

H. 5211 - Petition of Timothy A. Bassett that the Commonwealth assume the cost of operation of the MBTA.

1974

H. 2296 - Petition of Michael J. Daley and John F. Melia for legislation to provide that the Commonwealth assume the payment of the annual deficit of the MBTA.

H. 2301 - Petition of Board of Directors of the MBTA and W. Paul White relative to the organization and financing of said Authority.

H. 2852 - Petition of Melanie Kay and Barney Frank for the state assumption of half of the cost of services of the MBTA.

H. 3224 - Petition of Alan Paul Danovitch that the Commonwealth assume the cost of operation of the MBTA.

H. 3834 - Petition of Charles Robert Doyle that provision be made for the state assumption of the annual deficit of the MBTA.

H. 4837 - Petition of James J. Craven, Jr. for legislation to require the Commonwealth of Massachusetts to assume all the costs of the operation of the MBTA.

1975

S. 1496 - Petition of Jack H. Backman for legislation to provide payment by the Commonwealth of fifty percent of the cost of mass transportation service in the Commonwealth.

S. 1499 - Petition of Walter J. Boverini for legislation to requir the Commonwealth to pick up the total cost of operating expenses of the extension of the Massachusetts Bay Transportation Authority blue line.

S. 1504 - Petition of John W. Bullock for legislation to require the Commonwealth to assume all the costs of the operatio of the Massachusetts Bay Transportation Authority.

H. 718 - Petition of Raymond F. Rourke relative to improving the efficiency of the Massachusetts Bay Transportation Authority and providing for increased state aid.

H. 2212 - Petition of W. Paul White for legislation to provide additional financial assistance by the Commonwealth for the operation of the Massachusetts Bay Transportation Authority.

H. 3419 - Petition of Kevin H. White, Barney Frank, John F. Melia and another for legislation to provide for state payment of fifty percent of the net cost of operating the Massachusetts Bay Transportation Authority.

1976

H. 438 - Petition of Thomas F. Brownell relative to the assumption by the Commonwealth of the costs of the annual deficit of the Massachusetts Bay Transportation Authority.

H. 989 - Petition of the Board of Directors of the Massachusetts Bay Transportation Authority and W. Paul White relative to the financing of said Authority.

H. 1452 - Petition of Robert W. Gilette and William J. Flynn, Jr., relative to improving the efficiency of the Massachusetts Bay Transportation Authority and providing for increased state aid.

H. 2024 - Petition of John F. Melia that provision be made for the Commonwealth to assume fifty percent of the cost of the Massachusetts Bay Transportation Authority.

H. 2582 - Petition of Kevin H. White, John E. Melia and another that the Commonwealth assume fifty percent of the net costs of service of the Massachusetts Bay Transportation Authority.

H. 2765 - Petition of Theodore D. Mann, David J. Mofenson, Lois G. Pines, Jack H. Backman and Richard J. McGrath that the Commonwealth assume the full cost of mass transportation services in the Commonwealth.

H. 3133 - Petition of Brian J. Donnelly that all cities and towns of the Commonwealth be responsible for the payment of the annual deficit of the Massachusetts Bay Transportation Authority.

H. 3918 - Petition of Eleanor M. Campobasso that the Commonwealth assume the entire cost of the deficit of the Massachusetts Bay Transportation Authority.

H. 4112 - Petition of John F. Cusack that seventy-five percent of the net cost of service of the Massachusetts Bay Transportation Authority be paid by the Commonwealth and not assessed upon the cities and towns included in the districts constituting said Authority.

1977

S. 1273 - Petition of Jack H. Backman for legislation to establish the MBTA agency and state funding of the M.B.T.A.

H. 572 - Petition of William J. Flynn, Jr., relative to improving the efficiency of the MBTA and providing for increased state aid.

H. 1738 - Petition of Carla B. Johnston that provision be made for the payment by the Commonwealth of fifty percent of the net cost of service of the MBTA.

H. 2869 - Petition of Theodore D. Mann, David J. Mofenson, Jack H. Backman, A. Joseph DeNucci and Lois H. Pines for the assumption by the Commonwealth of the entire cost of transportation services.

H. 2870 - Petition of the Board of Directors of the MBTA and W. Pau White relative to the financing of said Authority.

H. 3658 - Petition of Brian J. Donnelly for legislation to require that all of the cities and towns of the Commonwealth be required to assume the payment of the annual deficit of the Massachusetts Bay Transportation Authority.

H. 3659 - Petition of the Massachusetts Mayors' Association, Paul E. Means, James E. Smith and A. Jasper DeNucci for legislation to require the payment by the Commonwealth of one hundred percent of the net cost of service of the MBTA.

H. 4203 - Petition of Brian J. Donnelly that all costs of operatio of the MBTA be assumed by the Commonwealth.

H. 4564 - Petition of Richard A. Voke that the Commonwealth assume the entire deficit of the MBTA.

H. 4696 - Petition of Thomas F. Brownell and another that provisio be made for payment by the Commonwealth of the net cost of service of the MBTA.

H. 4700 - Petition of Michael McGlynn for legislation to require that the Commonwealth assume the net cost of service of the MBTA.

1978

S. 1202 - Petition of Jack H. Backman for legislation to establish the Massachusetts transportation agency and state funding of the Massachusetts Bay Transportation Authority.

S. 1244 - Petition of Arthur H. Tobin and members of the House of Representatives that provision be made for an investigation and study by a special commission (including members of the General Court) relative to the operation, maintenance and finances of the Massachusetts Bay Transportation Authority.

H. 1312 - Petition of the Board of Directors of the Massachusetts Bay Transportation Authority, Lincoln P. Cole, Jr., and W. Paul White relative to the financing of said Authority.

H. 1928 - Petition of Kevin H. White and Barney Frank relative to the finances and organization of the Massachusetts Bay Transportation Authority.

H. 2501 - Petition of William J. Flynn, Jr., Anna P. Buckley, and Paul F. X. Moriarty relative to improve the efficiency of the Massachusetts Bay Transprotation Authority and providing for increased state aid.

H. 2867 - Petition of Brian J. Donnelly and Richard L. Walsh that the annual deficit of the Massachusetts Bay Transportation Authority be paid by all the cities and towns of the Commonwealth.

H. 3037 - Petition of Louis R. Nickinello and other members of the General Court relative to the finances and organization of the Massachusetts Bay Transportation Authority.

H. 3423 - Petition of John A. Businger to provide for fifty percent state assistance to the Massachusetts Bay Transportation Authority.

H. 3621 - Petition of Norman S. Weinberg relative to adjusting the formula for allocating the deficit of the Massachusetts Bay Transportation Authority.

H. 3970 - Petition of Charles Robert Doyle that the Commonwealth assume the entire deficit of the Massachusetts Bay Transportation Authority.

S. 1516 - Petition of Larry M. Means and John A. Brennan, Jr., for legislation to relieve the deficit assessment of the Massachusetts Bay Transportation Authority from the cities and towns and providing for 100 percent assumption by the Commonwealth.

H. 434 - Petition of William J. Flynn, Jr., relative to authorizing the towns of Ashland, Dover, Duxbury, hanover, Hamilton, Lynnfield, Marshfield, Medfield, Middleton, Millis, Norwell, Pembroke, Rockland, Sherborn and Topsfield to withdraw from the Massachusetts Bay Transportation Authority.

H. 1305 - Petition of Richard A. Voke that provision be made for the Commonwealth to assume the entire deficit of the Massachusetts Bay Transportation Authority.

H. 1924 - Petition of the Board of Directors of the Massachusetts Bay Transportation Authority, W. Paul White and Lincoln P. Cole, Jr., relative to the financing of said Authority.

H. 2116 - Petition of James V. Young and Daniel F. Pokaski relative to the finances and organization of the Massachusetts Bay Transportation Authority.

H. 2307 - Petition of Theodore D. Mann, Jack H. Backman, David B. Cohen, A. Joseph DeNucci and David J. Mofenson for legislation to require the Commonwealth to assume one hundred percent of the cost of mass transportation.

H. 2487 - Petition of John F. Cusack and Andrew J. Rogers, Jr., that the Commonwealth be required to assume full cost of the annual deficit of the Massachusetts Bay Transportation Authority.

H. 2853 - Petition of Charles F. Flaherty, Jr., and Barney Frank relative to the finances and organization of the Massachusetts Bay Transportation Authority.

H. 3063 - Petition of Richard L. Walsh relative to requiring the Commonwealth to assume all the costs of operation of the Massachusetts Bay Transportation Authority.

H. 3064 - Petition of Richard L. Walsh that provision be made for all of the cities and towns of the Commonwealth to assume the payment of the annual deficit of the Massachusetts Bay Transportation Authority.

H. 4094 - Petition of John A. Businger for legislation to provide for fifty percent state assistance to the Massachusetts Bay Transportation Authority.

H. 4099 - Petition of Louis R. Nickinello, Sherman W. Saltmarsh, Jr., John E. Murphy, Jr., Samuel Rotondi, Alfred A. Minahan, Jr., Andrew J. Rogers, Jr., Michael J. McGlynn, Elizabeth N. Metayer and another relative to the finances and organization of the Massachusetts Bay Transportation Authority.

H. 5046 - Petition of Charles Robert Doyle that the Commonwealth assume the entire deficit of the Massachusetts Bay Transportation Authority.

H. 435 - Petition of Charles Robert Doyle that the Commonwealth assume the entire deficit of the Massachusetts Bay Transportation Authority.

H. 1190 - Petition of John F. Melia and another for legislation to decrease the cost of the Massachusetts Bay Transportatio Authority to the property taxpayers of the Commonwealth.

H. 1393 - Petition of Richard A. Voke, Richard L. Walsh, John A. Businger, Philip W. Johnston and Gregory Williams Sulliva relative to requiring the Commonwealth to assume the ent cost of operation of the Massachusetts Bay Transportatio Authority.

H. 1965 - Petition of the Board of Directors of the Massachusetts Transportation Authority and W. Paul White relative to th financing of said Authority.

H. 2929 - Petition of John F. Cusack and Andrew J. Rogers, Jr., tha provision be made for state assumption of the entire annu deficit of the Massachusetts Bay Transportation Authorit

H. 4641 - Petition of Richard L. Walsh that provision be made for a of the cities and towns of the Commonwealth to assume the payment of the annual deficit of the Massachusetts Bay Transportation Authority.

H. 4642 - Petition of Richard L. Walsh relative to requiring the Commonwealth to assume all the costs of operation of the Massachusetts Bay Transportation Authority.

H. 5031 - Petition of William J. Flynn, Jr., for legislation to require the Commonwealth to assume seventy percent of the assessments payable by cities and towns comprising the territory of the Massachusetts Bay Transportation Authority.

H. 5032 - Petition of William J. Flynn, Jr., relative to improving the efficiency of the Massachusetts Bay Transportation Authority and providing for increased state aid.

H. 5283 - Petition of William J. Flynn, Jr., that provision be mad for the Commonwealth to pay one hundred percent of the cost of mass transportation services.

1981

H. 895 - Petition of William J. Flynn, Jr. for legislation to require the Commonwealth to assume seventy percent of the assessments payable by cities and towns comprising the territory of the Massachusetts Bay Transportation Authority.

H. 896 - Petition of William J. Flynn, Jr. relative to improving the efficiency of the Massachusetts Bay Transportation Authority.

H. 897 - Petition of William J. Flynn, Jr. that provision be made for the Commonwealth to pay one hundred percent of the cost of mass transportation service.

H. 1633 - Petition of Charles Robert Doyle that the Commonwealth assume the entire deficit of the Massachusetts Bay Transportation Authority.

H. 2396 - Petition of Charles F. Flaherty, Jr. relative to the finances and organization of the Massachusetts Bay Transportation Authority.

H. 3844 - Petition of Theodore D. Mann, Jack H. Backman and A. Joseph DeNucci for legislation to require the Commonwealth to assume the full liability for all costs, debts and expenses related to the operation of the Massachusetts Bay Transportation Authortiy.

1982

H. 437 - Petition of William J. Flynn, Jr., for legislation to require the Commonwealth to assume seventy percent of the assessments payable by the cities and towns comprising the territory of the Massachusetts Bay Transportation Authority.

H. 438 - Petition of William J. Flynn, Jr., relative to improving the efficiency of the Massachusetts Bay Transportation Authority and providing for increased state aid.

H. 439 - Petition of William J. Flynn, Jr., that provision be mad for the Commonwealth to pay one hundred percent of the costs of mass transportation services.

H. 440 - Petition of William J. Flynn, Jr., relative to the continued operation and financing of the Massachusetts Bay Transportation Authority.

H. 2376 - Petition of Nicholas A. Paleologos relative to the continued operation and financing of the Massachusetts Bay Transportation Authority.

H. 3094 - Petition of Louis R. Nickinello relative to the continue operation and financing of the Massachusetts Bay Transpo tation Authority.

H. 3700 - Petition of Thomas F. Brownell for legislation to requir that all deficit expenditures of the Massachusetts Bay Transportation Authority be funded by the Commonwealth and prohibiting such costs from being assessed upon any cities or towns.

APPENDIX A - 8 : Letters on Mitigating Measures from the M.B.T.A.

TRANSPORTATION AUTHORITY

James F. O'Leary
General Manager
50 High Street
Boston, Massachusetts 02110

July 18, 1983

The Honorable Kevin H. White, Mayor
City of Boston
City Hall Square
Boston, Massachusetts 02202

Dear Mayor White:

In 1982, the Central Transportation Planning Staff (CTPS) prepared an Environmental and Socioeconomic Impact Report of the MBTA's 1981 fare increase. As part of that analysis, CTPS estimated carbon monoxide (CO) concentrations at five street intersections in the City of Boston. These intersections had been designated by the Massachusetts Department of Environmental Quality Engineering as locations with potential for exceeding air quality standards for CO.

Of these five intersections, the analysis identified three with concentrations of CO which are estimated to exceed the standard of nine parts per million (ppm) for an eight-hour period.

Leverett Circle has an estimated increase in eight-hour concentrations of CO from 10.85 ppm to 11.43 ppm. As a result of the fare adjustments, the amount of CO in excess of the standard is estimated to increase.

At the interesection of Blue Hill Avenue and American Legion Highway, CO is estimated to increase from 8.87 ppm to 9.17 ppm, thereby exceeding the standard.

At the Boston University Bridge and Commonwealth Avenue, the CO concentration was estimated to remain at the above standard level of 9.79 ppm.

In accordance with the Massachusetts Department of Environmental Quality Engineering (see attached April 21, 1982 letter), the MBTA must address mitigating measures for CO to remain consistent with the State Implementation Plan for Air Quality.

The environmental impact on CO "hot spots" can be mitigated most cost-effectively through intersection redesign and other traffic engineering measures. Whereas such improvements are beyond the MBTA's jurisdiction, and two of the three intersections in question are the responsibility of the City, I am bringing these concerns to your attention.

In order to improve air quality and mitigate the adverse effects of the 1981 MBTA fare increase, as required to maintain consistency with the State Implementation Plan, I respectfully request that the City of Boston give priority to improvements at the intersection of Blue Hill Avenue and American Legion Highway and the intersection of Boston University Bridge and Commonwealth Avenue.

Thank you for your consideration.

Sincerely,

James F. O'Leary
General Manager

cc: R. Tierney

AUTHORITY

James F. O'Leary
General Manager
50 High Street
Boston, Massachusetts 02110

July 18, 1983

William J. Geary, Commissioner
Metropolitan District Commission
20 Somerset Street
Boston, Massachusetts 02108

Dear Commissioner Geary:

In 1982, the Central Transportation Planning Staff (CTPS) prepared an Environmental and Socioeconomic Impact Report of the MBTA's 1981 fare increase. As part of that analysis, CTPS estimated carbon monoxide (CO) concentrations at five street intersections in the City of Boston. These intersections had been designated by the Massachusetts Department of Environmental Quality Engineering as locations with potential for exceeding air quality standards for CO.

Of these five intersections, the analysis identified three with concentrations of CO which are estimated to exceed the standard of nine parts per million (ppm) for an eight-hour period. One of these intersections is under the jurisdiction of the MDC.

Leverett Circle has an estimated increase in eight-hour concentrations of CO from 10.85 ppm to 11.43 ppm. As a result of the fare adjustments, the amount of CO in excess of the standard is estimated to increase.

The remaining two intersections of concern are under the jurisdiction of the City of Boston.

The environmental impact on CO "hot spots" can be mitigated most cost-effectively through intersection redesign and other traffic engineering measures. Whereas such improvements for Leverett Circle are within MDC's area of control, I am bringing this matter to your attention.

In accordance with the Massachusetts Department of Environmental Quality Engineering (see attached April 21, 1982 letter), the MBTA must address mitigating measures for CO to remain consistent with the State Implementation Plan for Air Quality.

In order to improve air quality, mitigate the adverse effects of the 1981 MBTA fare increase and in response to DEQE's letter of April 21, 1983, I respectfully request that the MDC give priority to improvements at Leverett Circle.

Thank you for your consideration.

Sincerely,

James F. O'Leary
General Manager

cc: R. Tierney

APPENDIX B

Ridership Estimation Technique

APPENDIX B

RIDERSHIP ESTIMATION TECHNIQUE

The MBTA does not regularly count the number of riders it is carrying systemwide. It does, however, take periodic counts on buses and at selected rapid transit stations. Total system ridership can be derived from base information collected during these counts and from regularly collected revenue data adjusted by estimates of average fare levels. The methods currently used to estimate ridership are described below.

Three types of bus counts are made: (1) peak load point counts, (2) characteristic counts, and (3) specialized route segment counts. Peak load counts are made by the MBTA checkers once each quarter for each bus route. The number of passengers on each bus on a given route are recorded at the point of peak load. The data is collected by a checker who is outside the vehicle and must estimate the total number of riders. The data is then summarized to determine riders per bus over various time periods. Characteristic counts are performed by the MBTA upon special request from an MBTA department. The data collected provides total passenger boardings and elapsed time of a trip for the bus route under study. Specialized counts are also taken as needed and counts that provide information on fare type, pass usage, or ridership profile.

Turnstile readings and token counts are made on a daily basis and give some indication of the number of riders on the rapid transit lines. Passmeter readings are also reported daily; however, the reliability of these counts is questionable due to frequent equipment failures, which cause an understatement of ridership levels. The third component of rapid transit ridersip counts involves estimating the number of individuals who use the collector's turnstile or cash gates and whose presence is only recorded as revenue collected in the cash box. An average fare of these riders is necessary to estimate ridership levels.

To determine system ridership levels, revenue collected during a given time period is divided by the average fare paid on the system. This method can be applied separately to surface revenue and to rapid transit revenue, using the appropriate average fares. There is uncertainty surrounding the use of these estimates of ridership since it is directly related to the average fare value. It is, therefore, essential that a reliable estimate of average fare be available.

The MBTA conducted a sampling program during November 1981 to determine the average fare on buses and rapid transit. The number of persons boarding and the type of fare payment, whether adult full fare, prepaid pass, elderly free, elderly half fare, student half fare or other free, was recorded for a sample of buses and surface streetcars. In addition, revenue collected for

APPENDIX B

DERIVATION OF 1981 RIDERSHIP LEVELS

RAPID TRANSIT
UNLINKED TRIPS

okens used in Period 11 - 3,118,706 (141,759/*average weekday*)

ass uses -- *passmeter readings from RTL 210*
turnstyle data - 77,044
-- *passholders using gates or collectors*
turnstyles - 13,301

ash gate users
ollectors turnstyle users
73,595

ass sales - 49,432

ovember RTL revenue - $3,932,827

of unlinked trips/average weekday - 305,699

are mix

ses/pass - 44 *uses/month*

verage fare - 60.0 *cents*

SURFACE
UNLINKED TRIPS

Green Line Sample -- *Average fare and fare mix*

Bus Sample -- *Average fare and fare mix*

Period 11 Surface Revenue - $3,656,678

Pass Sales - 58,184

Surface Fare Mix and Average Fare

# of unlinked trips/average weekday - 422,125

Uses/pass - 57 *uses/pass/month*

Average fare - 39.6 *cents*

Total Unlinked Trips/Day = 727,824

NOTE: The survey did not include the Dorchester Branch and the Mattapan High Speed Line of the Red Line and the surface portion of theArborway Branch of the Green Line because they were closed for track reconstruction.

For additional information, see the source of this table; C.T.P.S. Tech. Report #39 1981 MBTA Fare-Mix Sampling Program: Analysis and Documentation, Feb. 1983.

Rapid Transit
Unlinked Trips

Tokens used in Period 11 - 3,376,144 (155,255/avg. weekday)

Pass uses -- passmeter readings from RTL210 turnstile data - 87647

-- passholders using gates or collector's turnstiles -22,581

Cash gate users
Collector's turnstile users 70,128

Pass sales - 56,715

Period II RTL revenue - $3,653,450

# of unlinked trips/average weekday - 335,581

Fare mix

Uses/pass - 39.2 uses/month

Average fare - 51.1 cents

Surface
Unlinked Trips

Green Line sample - average fare and fare mix

Bus Sample - average fare and fare mix

Period II surface revenue - $3,434,416

Pass sales - 52,359

Surface fare mix and average fare

# of unlinked trips/average weekday - 456,261

Uses/pass - 52.7 uses/pass/month

Average fare - 34.6 cents

Total Unlinked Trips/Day = 791,842

For additional information, see C.T.P.S. Tech. Report # 39 - 1981 Fare - Mix Sampling Program : Analysis and Documentation, Feb. 1983.

each surface trip was recorded. This has enabled CTPS to estimate an average surface fare in a much more accurate way than that with previously obtained data. Similar information was recorded for cash gate users at selected rapid transit stations. This data, supplemented by the turnstile token and passmeter readings permitted an estimate of average rapid transit fares.

The MBTA has proposed to undertake this type of sampling program on an annual basis. In November 1982, a second sampling was conducted and from it a ridership estimation and a calculation of average fare values for 1982 were produced. In an effort to obtain more reliable estimates of ridership, the MBTA is also investigating expanding the use of electronic pass readers to surface vehicles. This was described in Section 7.1.2 of this report. Furthermore, the MBTA will continue to examine the opportunity to build ridership counting features into other operating projects such as new types of on-board passenger counting and automatic vehicle monitoring systems.

APPENDIX C

Appendix C-1 Load Factors; Peak Hour and Direction p.321
Appendix C-2 Line Statistics for Bus Routes(by garage) Light Rail, and Rapid Transit Lines. p.335
Appendix C-3 Operating Capacities p.361

APPENDIX C - 1 : Peak Hour/Direction Load Factors for Bus Routes, Light Rail, and Rapid Transit

ppendix C

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

Load Factors - Peak Hour Peak Direction

te ber	Route	Number of Trips	Number of Seats	Number of Pas-sengers	Load * Factor	Date of Count
1	Harvard-Dudley/CA	5	225	385	1.71*	01/21/8
6	Army Base-South Station/CA	5	225	316	1.40*	02/25/8
7	City Point-South Station/CA	4	180	240	1.33*	02/25/8
8	Columbia Point-Dudley/CA	5	225	115	0.51	02/24/8
9	City Point-Cooley Square/CA	8	360	418	1.16*	03/10/8
0	City Point-Dudley/CA	4	180	98	0.54	02/24/8
1	City Point-Essex & Wash. via Bay View/CA	8	360	421	1.17*	03/10/8
5	Kane Square-Dudley/CA	6	270	376	1.39*	03/25/8
16	Franklin Park-Andrew	5	225	136	0.60	02/24/8
17	Fields Corner-Andres/CA	5	225	161	0.76	02/24/8
19	Fields Corner-Dudley Sta/CA	3	135	133	0.98	03/25/8
20	Fields Corner-Neponset & Adams/O	12	552	244	0.44	01/15/8
21	Ashmont-Forest Hills/AR	4	184	181	0.98	02/05/8
22	Ashmont-Dudley via Talbot/CA	5	225	249	1.11*	03/25/
23	Ashmont-Dudley via Washington/CA	9	405	571	1.41*	03/25/
24	Wakefield Avenue-Mattapan/AR	6	276	134	0.49	02/05/
26	Ashmont-Ashmont-Norfolk-Wash	9	414	209	0.50	02/04/
27	Mattapan-Ashmont/AR	2	92	129	1.40*	02/04/
29	Mattapan-Egleston/AR	13	598	718	1.21*	03/25/
30	Mattapan-Roslindale/AR	6	276	94	0.34	02/05/
32	Cleary Square-Arborway/AR	11	506	559	1.10*	03/09/
33	River & Milton St.-Mattapan/AR	4	184	210	1.14*	02/05/
34	Dedham Line-Arborway/AR	10	460	460	1.00	03/03/
34E	East Walpole-Arborway Station/AR	3	138	98	0.71	03/03/
35	Stimson & Wash-Arborway/AR	5	230	192	0.83	03/03/
36	Charles River Loop-Arborway/AR	8	368	368	1.00	03/03/

*Route with load factor which is 10% greater than the system average.

Appendix C

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

Load Factors - Peak Hour: Peak Direction

oute umber	Route	Number of Trips	Number of Seats	Number of Passengers	Load * Factor
37	Baker & Vermont-ARborway/AR	6	276	257	0.93
38	Wren Street-Forest Hills Station/AR	5	230	178	0.77
39	Copley Square-Arborway Station/AR	24	1,104	1,421	1.29*
40	Georgetown-Arborway/AR	2	92	131	1.42*
41	Center & Eliot-Dudley/AR	5	230	233	1.00
42	Arborway-Dudley via Wash. St./AR	5	230	164	0.71
43	Egleston-Stuart & Tremont/CA	5	225	304	1.04
44	Seaver Street-Dudley/CA	8	360	374	1.04
45	Franklin Park-Dudley/CA	4	180	283	1.57*
46	Heath Street & So. Huntington Dudley/AR	2	92	49	0.50
47	Central Square-Camb.-City Hosp./CA	6	270	225	0.83
50	Cleary Square-Arborway/AR	4	184	170	0.92
51	Cleveland Circle-Arborway/AR	4	184	204	1.11*
55	Queensbury-Copley/CA	3	135	118	0.87
57	Watertown-Kenmore/AL	11	550	586	1.07
60	Chestnut Hill-Kenmore/AL	6	300	138	0.46
63	Cleveland Circle-Central Sq/B	3	135	122	0.90
64	Oak Square-Central Square/B	3	135	165	1.22*
65	Brighton Center-Kenmore/AL	4	180	193	1.07
66	Allston-Dudley/CA	9	405	499	1.23*
68	Boston City Hospital-Copley/CA	5	225	89	0.40
69	Harvard-Lechmere	5	225	98	0.43
71	Watertown-Harvard/Brattle/B	10	450	740	1.64*
72.3	Huron Avenue-Harvard	6	270	197	0.73
73.2	Waverly-Harvard/Brattle/B	17	765	1,198	1.57*
73.9	No.Camb.-Camb. Common/B	19	836	748	0.89

*Route with load factor which is 10% greater than the system average.

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

Load Factors - Peak Hour Peak Direction

r	Route	Number of Trips	Number of Seats	Number of Pas-sengers	Load * Factor	Date of Count
	Belmont Center-Harvard/Brattle/B	6	270	233	1.05	02/03/81
	Arlington Heights-Harvard/B	24	1,080	1,282	1.19*	03/24/81
	Pleasant & Lake/B	4	180	252	1.40*	02/03/81
	Arlington Center-Lechmere/CH	5	225	218	0.97	01/28/81
	Rindge Avenue-Central Square/B	5	225	214	0.95	01/21/81
	Arlmont-Harvard/B	5	225	214	0.95	03/24/81
	Spring Hill-Kendall/B	2	90	82	0.91	01/28/81
	Sullivan-Union Square-Allston/B	4	180	150	0.83	02/02/81
	Clarehdon Hill-Lechmere via Som/B	10	450	363	0.81	01/28/81
	Clarendon Hill-Lechmere via Highland/B	8	360	270	0.75	01/28/81
	Clarendon Hill-Sullivan via Broadway/CH	8	360	418	1.16*	02/03/81
	Sullivan-Central Square/CH	6	270	106	0.39	02/02/81
	Sullivan-Haymarket via Main St.	6	270	317	1.17*	03/02/81
	Sullivan-Haymarket via Bunker Hill/CH	10	450	419	0.93	03/02/81
	West Medford-Sullivan/F	5	225	159	0.71	01/27/81
	Medford Sq-Harvard/Bra./F	7	315	387	1.24*	03/24/81
	Malden-Wellington via Comm./F	3	135	71	0.53	12/23/80
	Upper Highland Avenue-Well/F	4	180	144	0.80	05/07/81
	Elm Street-Wellington/F	5	225	169	0.75	01/27/81
	Salem Street, Sullivan/F	10	450	520	1.16*	02/03/81
	Malden Sq-Sullivan via Ferry/CH	8	360	250	0.69	02/23/81
	Malden-Sullivan via Faulkner/CH	2	90	89	0.99	02/23/81
	Lebanon-Wellington/F	8	360	169	0.47	02/23/81
	Linden Square-Wellington/F	5	225	312	1.34*	03/31/81
	Linden Square-Sullivan via Everett/CH	5	225	188	0.84	02/23/81
	Wonderland-Well.via/Wdlwn/CH	6	270	261	0.97	02/23/81

ute with load factor which is 10% greater than the system average.

Appendix C

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

Load Factors - Peak Hour Peak Direction

oute umber	Route	Number of Trips	Number of Seats	Number of Pas- sengers	Load * Factor
111	Woodlawn-Haymarket/CH	9	405	496	1.02
112	Everett Sq-Wood Isl. via Mystic Mall/CH	3	90	75	0.83
116	Wonderland-Maverick via Revere St/L	4	192	200	1.04
117	Wonderland-Maverick via Beach/L	4	192	254	1.32*
119	Beachmont-City Hall/L	4	192	112	0.58
120	Orient Heights-Maverick/L	4	192	208	1.08
121	Wood Island Pk-Maverick/L	4	192	199	1.04
130	Melrose-Wyoming Square/L	2	96	61	0.64
131	Melrose-Highland-Malden/CH	3	135	168	1.24*
134	No. Woburn-Wellington/F	4	180	124	0.69
135	Wakefield Square-Malden/CH	2	90	92	1.02
136/137	Reading Square/Malden/CH	5	225	251	1.12*
170	Northwest Ind-Dudley/AL	2	90	86	0.96
210	Quincy-Fields Corner/Q	3	138	80	0.58
211	Quincy-Squantim/Q	2	94	93	.99
214	Quincy-Germantown/Q	10	460	385	0.84
215	Quincy Center-Ashmont via Quincy/Q	5	230	243	1.06
216	Quincy-Hough's Neck/Q	8	368	369	1.03
217	Ashmont-Wollaston Beach/Q	3	138	71	0.51
220	Quincy-Hingham/Q	6	276	297	1.08
221	Quincy-Fort Point/Q	1	46	28	0.61
222	Quincy-E. Weymouth/Q	7	322	307	0.95
225	Quincy Center/Weymouth Landing/Q	8	368	282	0.77
230	Quincy Center-Brockton Line via Braintree Station/Q	5	230	195	0.85
236	Quincy Center-So. Shore Plaza/Q	2	92	61	0.66
238	Quincy Center-Crawford Square	3	138	100	0.72

*Route with load factor which is 10% greater than the system average.

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

Load Factors - Peak Hour Peak Direction

e er	Route	Number of Trips	Number of Seats	Number of Pas-sengers	Load * Factor	Date of Count
	Crawford Square/Q	5	230	270	1.17*	02/11/81
	Mattapan-Quincy via E. Milton/Q	3	138	140	1.01	10/22/80 10/24/80
	Riverside-So. Station/AL	11	550	602	1.09	02/26/81
	Brighton Center-So. Station/AL	10	500	517	1.03	02/26/81
	Watertown-Copley Sq./AL	6	300	284	0.95	02/26/81
	Watertown-So. Station/AL	15	750	811	1.08	02/26/81
	Waltham-So. Station/AL	5	250	256	1.02	02/26/81
	Needham-So. Station/AL	10	500	457	0.91	12/02/80
	Roslindale Square-Copley/AL	2	100	90	0.90	12/02/80
	Elm Street-Haymarket/F	5	225	251	.92	04/24/81
	West Medford-Haymarket/F	5	225	269	.76	03/0[illegible]/81
	Central Square-Boston via Western Ave/L	4	192	226	1.18*	07/17/81
	Central Square-Boston via Cliftondale/L	10	480	463	0.96	07/17/81
	Cent.Sq-No.Saugus via Myrtle/L	2	96	42	0.44	04/02/81
	Saugus-Malden/L	3	144	121	0.84	03/31/81
	Central Square-Pine Hill/L	2	96	46	0.48	04/07/80 04/08/80
	Central Square-Happy Valley/L	2	96	38	0.40	11/07/80
	Central Square-Lakeside via Eastern/L	2	96	27	0.28	04/02/81
	Central Square-Nahant/L	2	96	52	0.54	03/09/81
	Central Square-Boston via Lynnway/L	7	336	402	1.20*	
	Central Square-Marblehead via Paradise/L	2	96	111	1.16*	03/02/81
	Central Square-Marblehead via Humphrey/L	2	96	114	1.18*	03/02/81
	Salem-Boston via Western Avenue/L	7	336	382	1.14*	03/02/81
	Salem-North Beverly/L	2	100	38	0.38	12/12/80 12/15/80
	Salem-Lynn via Loring/L	3	144	117	0.55	02/10/81
	Roberts-Newton Corner/AL	1	50	39	0.78	02/26/81

ute with load factor which is 10% greater than the system average.

Appendix C

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

Load Factors - Peak Hour Peak Direction

Route Number	Route	Number of Trips	Number of Seats	Number of Passengers	Load * Factor
521	Waverly-Newton Corner/AL	3	100	92	0.92
522	Waltham Highlands-Newton Corner/AL	1	50	30	0.60
523	Cedarwood-Central Square/B	3	135	145	1.07
525	Lexington-Waltham/B	1	45	24	0.53
527	Auburndale-Newton Corner/AL	2	100	43	0.43
528	Hanscom-Harvard/Brattle/B	2	92	101	1.10*
529	Bedford VA Hospital-Arl. Heights/B	2	90	70	0.78
530	Five Forks-Arlington Center/B	1	45	10	0.22
532	Needham Jct-Watertown/AL	2	100	59	0.59
533A	Dedham Mall-Watertown/AR	3	138	74	0.48
700	Burlington-Boston/CH	4	180	214	1.13*
701	Burlington-Boston via I-93/CH	6	270	309	1.14*
	142 Routes Recorded.			AL - Albany	
	100 Routes-70% Serve Minority Areas.			AR - Arborway	
	41 Routes-29% have a load factor 10% greater than the system average.			B - Bennett	
				CA - Cabot	
	29 Routes-20% have a load factor 10% greater than the system average and serve minority areas.			CH - Charlestown	
				F - Fellsway	
	12 Routes-8% have a load factor 10% greater than the system average and serve non-minority areas.			L - Lynn	
				Q - Quincy	
	Overall Load Factors - All MBTA Buses			S - Somerville	
	$\frac{\text{Total Passengers}}{\text{Total Seats}} = \frac{35,720}{36,031} =$	0.994			
	10% Greater than Average Load = 1.09				

*Route with load factor which is 10% greater than the system average.

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

Rail Load Factors - AM Peak Hour/Peak Direction

oute No.	Route	Number of Trips	Number of Seats	Number of Passengers	Load Factor*	Date of Count
811	Boston College-North Station	26	1,300	2,587	1.99	03/11/81
833	Cleveland Circle-Park Street at Arlington	26	1,196	2,559	2.14	03/12/81
850	Riverside-Lechmere at Arlington	24	1,320	2,550	1.93	02/12/81
	Mattapan-Ashmont at Cedar Grove	20	920	1,202	1.31	
	Braintree-Harvard at Andrew	36	2,124	7,340	3.46	02/18/81
	Ashmont-Harvard at Andrew	36	2,124	6,119	2.88	02/18/81
	Oak Grove-Forest Hills at North Station	52	2,704	8,551	3.16	02/17/81
	Wonderland-Bowdoin at Aquarium	60	2,520	5,800	2.30	02/18/81
	TOTAL	280	14,208	36,708	2.59	

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*Designates routes which have a load factor 10 percent greater than the system load factor.

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

Light Rail Load Factors - AM Peak Hour/Peak Direction

Route No.	Route	Number of Trips	Number of Seats	Number of Passengers	Load Factor*	Date of Count
811	Green Line: Boston College-North Station	26	1,300	2,587	1.99	03/11/81
830	Green Line: Cleveland Circle-Park Street	26	1,196	2,559	2.14	03/12/81
850	Green Line: Riverside-Lechmere	24	1,320	2,550	1.93	03/12/81
	Green Line TOTAL	81	3,816	7,696	2.02	
899	Red Line: Mattapan-Ashmont	16		1,370		

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*Designates routes which have a load factor 10 percent greater than the system load factor.

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

Rapid Rail Load Factors - AM Peak Hour/Peak Direction

Route	Number of Trips	Number of Seats	Number of Passengers	Load Factor*	Date of Count
Blue Line	60	2,520	5,800	2.30	02/18/81
Orange Line	52	2,704	8,551	3.16	02/17/81
Red Line: Ashmont-Harvard	36	2,124	6,119	2.88	02/18/81
Red Line: Braintree-Harvard	36	2,124	7,340	3.46	02/18/81
Red Line TOTAL	72	4,248	13,459	3.17	

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*Designates routes which have a load factor 10 percent greater than the system load factor.

APPENDIX C - 2 : Line Statistics for Bus Routes (by garage), light rail, and rapid transit lines for Winter 1980 and Spring of 1982.

LINE STATISTICS

GARAGE: CABOT GARAGE

DATE: WINTER 1980

	WEEKDAY						WEEKEND	
TERMINII	A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	SAT.PEAK V.H.	SU PEA V.H
Harvard - Dudley	11-6	7-9	11-7	12-6/7	4-15	4-15	7-11	[illegible]-
So. Station - North Sta.	4-7/8	-	2-15	3-15	-	-	-	-
Army Base - South Sta.	-22	-	1-34	-22	-	-	-	-
Army Base - Haymarket	4-22	-	2-22	3-22	-	-	-	-
City Point-Franklin&Arch	4-12	A	1-15	4-15	1-40	1-40	2-30	1-
Columbus Point - Dudley	3-15	2-30	2-30	2-30	1-40	1-40	2-30	1-
City Point - Copley +09	7-8	4-15	7-10	8-8	1-40	1-40	3-15	2-
City Point - Dudley	5-10	3-20	4-20	4-16	2-40	1-40	3-20	[illegible]-
City Pt.-Summer&Chauncy	10-6	4-15	9-8	9-8	1-40	1-40	5-12	2-
Savin Hill-Northamp&Wash.	1-40	-	1-40	1-40	-	-	-	-
Kane Sq. - Dudley	5-8/7	2-15	4-9	4-9	1-30	1-30	3-10	2-
Franklin Park - Andrew	*3-24	2-20	-	*3-25	1-30	1-30	2-20	2-
Egleston - Andrew	2-24	-	4-15	2-25	-	-	-	-
Fields Corner - Andrew	4-11	3-15	4-15	4-12	1-40	1-40	3-15	2-
Ashmont - Andrew	2-30	1-60	2-30	2-30	-	-	1-60	1-
Fields Corner - Dudley	3-15	-	-	2-20	-	-	-	-
Ashmont-Dudley via Talbot	6-9	4-13	5-11	5-11	2-30	2-30	5-10	1-
Ashmont - Dudley via Wash	9-6	4-13	5-10	6-9	2-45	1-30	5-10	2-
Egleston - Dudley	2-12	1-22	2-12	2-12	1-20	1-20	2-13	1-
Egleston - Park & Tremont	7-9	5-12	7-9	7-9	2-30	2-30	5-11	3-
Seaver - Dudley	3-9	2-12	3-12	3-9	1-30	1-30	2-12	2-
Franklin Park - Dudley	4-8	3-12	4-10	4-10	1-32	1-32	4-9	2-
Cent.Sq.-Camb.-Bost.C.Hsp	9-10	4-20	7-12	7-12	2-30	2-39	4-20	2-
State Hosp. - Dudley	-60	-	-	-	-	-	-	-
Northampton - Downtown	1-40	1-50	1-50	1-50	-	-	1-50	-
Queenberry - Copley	1-25	1-30	1-30	1-30	1-30	1-30	1-30	1-
Watertown - Kenmore	A	A	A	A	5-12	5-12	9-7/8	4-
Chestnut Hill - Kenmore	A	A	A	A	1-60	1-45	2-30	2-
Brighton Center - Kenmore	A	A	A	A	-	-	2-30	-
Allston - Dudley	9-6/7	5-12	9-8	9-8	2-30	2-30	5-12	3-
City Hospital - Copley	2-15	1-30	1-30	1-35	-	-	-	-
Watertown-Fed.&Franklin	A	A	A	A	-	-	4-15	-
Roberts - Newton Corner	A	A	A	A	-	-	2-60	1-
Waverly - Newton Corner	A	A	A	A	-	-	1-60	-
Waltham Hld. - Newton Cor.	A	A	A	A	-	-	1-60	-
Auburndale - Newton Crnr.	A	A	A	A	-	-	1-60	-
Framingham - Newton Crnr.	A	A	A	A	-	-	2-60	-
Needham - Watertown	A	A	A	A	-	-	2-45	-
Schools	6	1	11					
Run as directed								
Kndy Lbry-Columbia Shttl	-	-	-	-	-	-	1-20	1-
Needham-Dwntn. Shuttle	-	-	-	-	-	-	2-60	
TOTAL	127	60	110	109	33	31	94	4

ES: H. Headway

V. Vehicles

.FOREST HILLS-U MASS.

A.OPERATED FROM ALBANY

LINE STATISTICS

GARAGE: ALBANY

DATE: WINTER 1980

		WEEKDAY						WEE
UTE O.	TERMINII	A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	SAT.PE V.H.
	City Pt. Mart McCormack H	-	1-60	1-60	-	-	-	-
	Army Base-South Station	C	C	1-38	-	-	-	-
	Watertwon - Kenmore	14-4/5	7-9	12-7/8	13-5/6	C	C	C
	Chestnut Hill - Kenmore	5-20	2-35	3-28	5-20	2-30	-	C
	Brighton Ctr. - Kenmore	3-20	2-30	2-30	3-20	-	-	C
.3	Northwest Ind. - Dudley	-	-	-	1-	-	-	-
.2	Riverside-Fed. & Franklin	14-4	-	4-15	13-4	2-30	-	-
.3	Brighton Cir.Fed.&Frankln	9-6	-	4-15	9-5	-	-	-
	Watertwon - Copley Square	5-10	-	-	4-12	-	-	-
	Riverside-Copley Square	3-20	-	-	3-17	-	-	-
.3	Watertown-Franklin & Fed.	15-7	4-15	8-10	14-3	-	-	C
.1	Walth.-Fed. & Franklin	6-13	-	3-20	6-12	-	-	-
.1	Roberts - Newton Corner	2-60	2-60	2-60	2	-	-	-
.2	Waverly-Newton Corner	1-60	1-60	1-60	1-60	-	-	C
.2	Walth. Hld.-Newton Corner	1-60	1-60	2-20	1-60	-	-	C
.1	Auburndale-Newton Corner	2-30	1-60	2-60	2-35	-	-	C
	Framingham-Newton Corner	4-30	2-60	3-30	4-30	-	-	C
	Needham Sq. - Watertown	3-30	2-45	3-30	3-30	-	-	C
	Kennedy Lib.Columbia Shut	-	1-20	1-20	1-20	-	-	C
	Needham-Downtown Shuttle	19-5	2-60	4-30	18-5	2-100	1-	C
	Roslindale Sq.-Cop.Shuttle	3-30	-	-	3-30	-	-	-
	Watertown	1		1	1			
	School	1		11				
7	City Pt.-Franklin & Arch	-	3-20	3-20	-			
	TOTAL	111	31	71	107	6	1	

NOTES: H. Headway
V. Vehicles
RAD. Run as directed

LINE STATISTICS

GARAGE: ARBORWAY

DATE: WINTER 1980

TERMINII	WEEKDAY						WEEKEND	
	A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	SAT.PEAK V.H.	SUN PEA. V.H
Ashmont - Forest Hills	3-15	1-45	2-25	2-25	-	-	1-45	-
Wakefield Ave. - Mattapan	3-17	1-40	2-25	2-25	-	-	1-45	-
Gallivan Blvd. - Ashmont	3-12	2-20	2-20	3-12	-	-	2-20	-
Norfolk St. - Ashmont	2-12	1-20	2-20	2-13	-	-	1-30	-
Ashmnt-Ashmnt-Nrflk-Wash.	-	-	-	-	1-30	1-30	-	1-3
Mattapan - Ashmont	1-30	1-30	1-30	1-30	1-60	1-60	1-30	1-6
Mattapan - Arborway	2-20	-	1-30	1-30	-	-	-	-
Mattapan - Egleston	11-4/5	6-10	10-5	11-5	3-15	3-15	6-9	-1
Mattapan - Roslindale	2-20	1-60	2-20	2-30	-60	-60	1-40	-6
Wolcott Sq. - Mattapan	2-17	1-40	2-25	2-25	-	-	1-40	-
Wolcott-Matt via Truman Hw	-	-	-	-	1-45	1-45	-	1-4
Cleary Sq. - Arborway	8-3/4	3-13	6-7	8-5	2-30	2-30	4-10	2-3
River&Milton Sts.-Mattapan	3-15	1-60	2-20	2-30	-	-	1-60	-
Dedham Line - Arborway	8-5	3-30	8-7	10-5	2-30	2-30	6-10	2-3
E. Walpole - Arborway	6-15	4-30	4-30	6-12	1-60	-60	1-30	-6
Stimson & Wash. - Arborway	4-12	2-30	4-20	5-15	-90	-90	2-30	1-9
Charles River Loop-Arbrwy.	9-6	2-30	6-12	7-7	2-45	1-45	4-15	1-4
Baker & Vermont - Arborway	3-12	2-30	4-20	4-15	1-90	1-90	2-30	-9
Wren St.-Green St. Station	2-16	2-22	-	-	-	-	2-23	1-4
Wren St.-Forest Hills Sta.	-	-	3-15	2-22	1-40	1-40	-	-
Arborway-Brigham R.A.D.	-	-	3-20	3-20	-	-	-	-
Georgetown - Arborway	1-50	-30	2-25	2-25	-	-	1-50	1-4
Center & Eliot - Dudley	3-10	2-17	3-13	3-13	1-30	1-30	3-12	-3
Heath & So. Hunt. - Dudley	1-30	1-30	1-30	1-30	1-30	-	1-30	1-3
Cleary Sq. - Arborway	3-18	2-30	3-20	3-20	-	-	2-30	
Cleveland Circle-Arborway	5-15	2-30	6-15	6-20	1-60	1-60	2-30	-
Boston College-Blandford	4-13	-	-	3-20	-	-	-	-
Needham Ind. Prk-Dudley	1-X	-	-	1-X	-	-	-	-
Dedham Mall - Watertown	3-30	3-30	3-30	3-30	-	-	@1-60	
Cntr&Eliot-Jm. Pln. Loop	-	1-30	1-30	-	-	-	1-30	
School	28	1	32					
TOTAL	121	45	115	95	18	15	47	7

TES: H. Headway
V. Vehicles
@ Oak Hill - Newton Corner
X Irregular Service

GARAGE: BENNETT ST.

LINE STATISTICS

DATE: WINTER 1980

		WEEKDAY						WEEK
ROUTE NO.	TERMINII	A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	SAT.PE V.H.
3	Cleveland Cr.-Central Sq.	3-20	2-30	3-20	3-20	1-60	1-60	2-30
4.5	Oak Sq. - Central Sq.	3-20	2-30	4-15	4-15	1-60	1-60	2-30
9	Harvard Sq. - Lechmere	4-13	3-15	4-12	3-15	1-30	1-30	3-15
1.4	Watertown-Harvard/Brattle	-	-	-	-	-	-	-
2.4	Huron Ave-Harvard/Brattle	-	-	-	-	1-30	1-30	-30
3.5	Waverly-Harvard/Brattle	-	-	-	-	-	-	-
4.3	Belmont-Cntrl-Hrvd/Brttl	4-12	2-30	4-15	4-14	1-40	1-40	2-30
5	Harvard Sq. - Kendall	2-15	1-30	1-30	1-32	-	-	-
7.4	Arl.Hgts-Benn-Hrvd/Brttl	31-4	11-7	17-5	25-3	9-7/8	6-10	11-8
7.5	Arl. Cntr-Benn-Hrvd/Brttl	-4	-	-	-	-	-	-
8.5	Park Cir.-Harvard/Brattle	4-14	2-30	4-15	4-13/14	1-60	1-60	2-30
3.1	Rindge Ave.-Central Sq.	4-13	3-20	5-15	5-13	1-45	1-45	3-20
34.3	Arlmont-Harvard/Brattle	4-17	-	4-15	5-13/14	-	-	2-30
35.3	Spring Hill - Kendall	2-15	1-50	2-30	2-20	-	-	1-30
36.6	Union Sq-Som-Union Sq-Alls	S5-15	2-30	S5-15	5-15	1-50	1-50	2-30
37	Clarendon Hill - Lechmere	3-17	3-17	8-7/8	*3-15	2-30	1-40	4-15
37.2	Arl-Lechmere via Somv. Ave	4-17	-	-	5-15	-	-	-
38	Clarendon Hill-Lechmere	10-5	3-15	5-11	7-8	2-30	1-40	3-15
523.3	Cedarwood-Central Sq. Camb	6-20	4-30	6-20	6-20	1-60	1-60	4-30
525.1	Lexington - Waltham	1-65	1-60	1-70	1-70	-	-	1-60
528.4	Arl.Hgts-Hanscom Air Base	-	-	-	-	-	-	1-60
528.3	Hanscom AirBase-Hrvd/Brttl	4-30	2-60	2-60	4-30	-	-	-
529	Arl.Hgts.-Bedf. V.A.Hosp.	2-30	1-60	2-30	3-35	-	-	1-60
530.5	Five Forks-Arlington Cent.	1-60	-	1-60	1-60	-	-	-
	School	1		16				
	TOTAL BUSES	98	43	94	91	22	17	44
	TRACKLESS TROLLEY							
71.2	Watertown-Harvard/Brattle	7-6	4-10	5-9	6-7/8	2-30	2-30	4-1
72.3	Huron Ave.-Camb. Common	3-10	1-30	3-10	3-10	-	-	1-3
73.2	Waverly-Harvard/Brattle	14-3/4	5-11	9-5	10-4/5	1-30	1-30	5-1
73.9	No. Camb.-Camb. Common	10-3	3-10	7-5	9-4	-	-	4-9
	TOTAL TRACKLESS TROLLEY	34	13	24	28	3	3	14

NOTES: H. Headway
V. Vehicles
B.Sunday-Holiday Bus
* Davis Sq.-Lechmere

LINE STATISTICS

GARAGE: CHARLESTOWN

DATE: WINTER 1980

TERMINII	WEEKDAY						WEEKEND	
	A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	SAT.PEAK V.H.	PEA V.H
Arlington Center-Lechmere	9-7/8	4-17	5-15	6-12	2-25	2-25	5-14	-
Clarendon Hill-Sullivan	6-7	3-15	4-11	8-7/8	1-40	1-40	3-15	-
Davis Sq.-Sllvn. via Hlnd	1-49	1-45	1-45	1-50	-	-	-	-
Sullivan Sq.-Central Sq.	5-12	3-15	3-15	3-15	1-40	1-30	2-20	-
Slvn.Sq.-Smr&Chncy via Mn	3-15	2-30	3-17	3-17	1-30	1-30	2-30	-
Sull-Smmr-Chncy,Bnkr.Hill	9-5/6	3-20	7-10	8-6/7	1-30	1-30	3-20	-
West Medford - Sullivan	F	F	F	F	1-45	1-50	3-20	-
Mdfrd.Sq.-Benn.St. via Gr	F	F	F	F	2-40	2-40	6-15	-
Upper Hld.-Wellington	F	F	F	F	1-60	1-60	3-23	-
Elm St. - Wellington	F	F	F	F	1-35	1-35	2-20	-
Salem St. - Sullivan	F	F	F	F	1-45	1-40	6-15	-
Malden Sq.-Sull.via Ferry	9-8	2-30	4-20	5-12	2-25	1-45	2-30	-
Malden-Sull. via Faulkner	2-30	2-35	2-35	2-35	1-60	-	2-35	1-
Lebanon - Wellington	F	F	F	F	1-50	1-50	4-20	2-
Linden - Wellington	F	F	F	F	1-45	1-45	5-30	
Lndn-Sllvn. via Everett	7-8	2-25	3-20	5-12	1-32	1-45	2-30	-
Brdwy&Prk Ave-Wllngtn via Woodlawn	-	-	-	-	-	-	-	-
Woodlawn - Haymarket Sq.	-	-	-	-	-	-	-	-
Bellingham - Wood Island via Central Ave.	-	-	-	-	-	-	-	-
Wndrlnd-Mvrk via Revere St	-	-	-	-	-	-	-	-
Wndrlnd-Mvrk via Beach St	-	-	-	-	-	-	-	-
Rvr. Cty Hl - Beachmont-Cooledge St.	-	-	-	-	-	-	-	-
O. Hts. Sta-Maverick Sta. via Jffrs. Pt. Wldmr. Ave	-	-	-	-	-	-	-	2-
Melrose-Highland-Malden	2-30	1-X	1-60	2-30	-	-	-	-
Medford Sq. - Wellington	F	-	-	F	1-45	1-45	-	-
Wakefield Sq.-Malden Sta.	1-60	-	1-60	2-60	1-60	-	-	-
Rdng-Mldn via Lakeside	2-60	2-60	1-120	1-65	-	-	2-60	-
Rdng Sq. - Malden Sta.	1-60	1-60	2-120	1-60	-	-	1-60	-
Somerville Mini Bus	-	1-70	1-80	-	-	-	1-70	-
Brlngtn Ln-Park Sq.Boston	6-15	2-60	2-60	4-25	1-60	-	2-60	-
Brlngtn Ln-Park Sq. via Woburn Sq. Interstate 93	2-75	-	-	-	-	-		
Brlngtn Ln-Copley Square	4-10	-	-	-	-	-		
Woburn Sq. - Park Sq.	2-40	-	-	-	-	-		
Burl.Ml-Pk.Sq via Wbrn Sq	3-25	-	-	-	-	-		
Burl.Ln-Pk.Sq via Mass Pk	-	-	-	2-26	-	-		
Burl.Ln-Gov. Cntr. Boston	-	-	-	1-60	-	-		
Burl.Ln-Hymk Sq via In 93	-	-	-	8-10	-	-		
Burl-Hymkt via 128	-	-	-	1-60	-	-		
School	6		20					
TOTAL BUSES	80	29	60	63	21	17	56	3

OTES: H. Headway
V. Vehicles
X. Irregular S

E. Eagle Garage
F. Fellsway Garage

LINE STATISTICS

GARAGE: FELLSWAY

DATE: WINTER 1980

		WEEKDAY						WEE
ROUTE NO.	TERMINII	A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	SAT.P V.H.
5	West Medford - Sullivan	6-12	3-20	4-15	4-15	C	C	C
6 7.8	Mdfrd.Sq.-Hrvrd/Brttl	10-8	6-35	6-15	11-8	C	C	C
7.5	Malden-Wllngtn via Comm.	2-30	1-45	1-50	2-25	-	-	-
9.7	Upper Highland-Wellington	5-15	2-30	3-20	3-20	C	C	-
1 0.3	Elm St. - Wellington	3-13	2-20	3-15	3-13	C	C	C
1 1	Salem St. - Sullivan	6-12	-	3-15	M3-15	C	C	C
1 1.3	Malden Sta. - Sullivan	6-12	5-15	5-15	5-15	-	-	-
1 6	Lebanon - Wellington	5-12	3-20	4-20	4-20	C	C	C
1 8.6	Linden - Wellington	5-15	2-30	4-18	4-18	C	C	C
1 4.5	No. Woburn - Wellington	2-60	2-60	2-60	2-60	-	-	C
4.6	Winthrop St.- Wellington	1-60	1-60	1-60	1-60	-	-	C
4.7	Medford Sq. - Wellington	1-30	-	-	1-30	C	C	C
5.1	Elm St. - Haymarket	3-13	-	-	4-12	-	-	-
26.1	West Medford - Haymarket	4-13	-	-	4-13	-	-	-
	School	5		14				
	Run as directed	1						
	TOTAL BUSES	65	27	50	51			

NOTES: H. Headway
V. Vehicles
M. Medford Sq. - Sullivan
X. Irregular Service

LINE STATISTICS

GARAGE: EAGLE ST.

DATE: WINTER 1980

		WEEKDAY						WEEKEND	
	TERMINII	A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	SAT.PEAK V.H.	SU PEA V.H
	Wonderland - Wellington	6-18	3-20	4-20	3-25	-	-	3-20	C
2	Woodlawn - Wellington	-20	-	-	2-25	1-50	1-40	-	C
5	Woodlawn - Haymarket	11-4/5	4-15	5-12	8-7	2-35	2-25	4-15	C
6	Everett Sq. - Wood Island	2-30	2-30	2-30	2-30	-	-	2-30	C
4	Wond.-Maverick-Revere St.	4-15	4-20	4-20	3-20	1-40	2-40	7-20	C
5	Wond.-Maverick via Beach	4-15	3-20	3-20	4-20	2-40	1-40	-20	C
3	Revere Cty Hall-Beachmont	2-20	2-30	2-30	2-20	1-40	1-40	1-40	C
	Orient Hghts-Maverick	4-13	3-20	5-15	4-15	1-50	1-50	3-20	[illegible]
	Wd.Islnd Prk-Maverick Lex	2-15	1-30	1-30	1-20	-	-	1-30	[illegible]
	School	2	1	14					
	TOTAL BUSES	37	23	40	29	8	8	21	

OTES: H. Headway
V. Vehicles
C. Charlestown

LINE STATISTICS

GARAGE: QUINCY

DATE: WINTER 1980

		WEEKDAY						WEE
ROUTE NO.	TERMINII	A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	SAT.P V.H.
20	Flds. Cor-Neponset&Adams	-10	2-20	2-20	2-20	1-30	1-30	1-3
20.1	Flds. Cor-Neponset. Belt	-	-	-	-	-	-	1-3
20.2	Flds. Cor-Adams & Hallett	2-20	1-20	2-15	3-10	-	-	-
20.7	Gal.Blvd-Flds.Cor.via Adms	3-8	-	-	-	-	-	-
10	Qncy-No.Quincy via Hancock	-	1-30	-	1-30	-	-	-
10.3	Quincy - Fields Corner	2-25	-	3-20	3-20	-	-	1-3
11	Quincy - Squantum	2-30	1-60	1-60	2-30	-	-	1-6
12.2	Qncy-No.Quincy via Billing	1-60	1-60	1-60	1-60	-	-	1-6
14.1	Quincy - Germantown	4-8	1-40	2-20	2-20	-	-	1-4
15.1	Qncy-Ashmnt via W. Quincy	3-20	2-30	3-20	4-20	1-60	1-60	2-3
16	Quincy - Houghs Neck	5-15	1-40	2-20	2-20	1-45	1-45	1-4
17	Wollaston - Ashmont	2-30	1-60	1-60	2-30	-	-	1-6
20.1	Quincy - Hingham	6-10	2-30	2-25	5-20	1-60	1-60	2-6
21	Quincy - Fort Point	1-70	-	-	-	-	-	-
22	Quincy - East Weymouth	4-12	2-30	2-30	4-20	1-60	1-60	2-3
25.1	Qncy Ctr-Wymth via Desmns	2-30	1-60	1-120	1-20	1-60	1-60	2-6
25.4	Quincy Cntr-Weymouth Lndng	2-30	1-60	1-60	3-15	-60	1-60	-
28	Quincy Cntr-E. Braintree	1-60	1-60	1-60	-60	-	-	-6
30.1	Quincy Cntr-S. Braintree	-	-	-	2-30	-	-	-
30.3	Quincy Center-Holbrook	6-10	1-60	2-60	5-15	1-60	-	2-6
37	Qncy Ctr-S.Shore Plaza	-30	1-60	1-60	-	-	-	1-6
38	Quincy Center-Crawford Sq	2-27	1-60	1-60	2-30	1-60	1-60	1-6
40.1	Crawford Sq.- Ashmont	7-10	3-30	4-30	9-10	1-60	1-60	4-6
45.4	Qncy-Mattapan via E.Milton	2-30	1-60	2-30	2-30	-	-	1-6
	School	12		35				
	TOTAL BUSES	69	25	69	55	9	9	25

NOTES: H. Headway
V. Vehicles

LINE STATISTICS

GARAGE: LYNN

DATE: WINTER 1980

	WEEKDAY						WEEKEND	
TERMINII	A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	SAT.PEAK V.H.	SU PE V.
Lebanon St. - Wyoming Ave.	2-30	1-60	2-30	2-30	-	-	1-60	-
Lynn-Boston via Western Av	5-15	2-30	3-20	7-15	1-60	1-60	2-30	2-
Linden - Revere Beach	1-30	-	1-40	1-35	-	-	-	-
6 Northgate - Revere House	-	1-60	-	-	-	-	1-60	-
Lynn-Boston via Cliftondale	8-8	1-60	2-60	10-10	1-60	1-60	1-60	1-
Central Sq. - Oaklandvale	1-30	1-60	1-60	1-60	-	-	1-60	-
Central Sq.-North Saugus	2-30	1-60	2-60	2-30	-	-	1-60	-
1 Saugus - Malden	1-60	1-60	2-40	2-40	-	-	2-40	-
8 Granada Hlds.-Malden Sta.	2-40	1-60	1-40	1-40	-	-	1-30	-
Cent.Sq.-Myrtle & Holyoke	1-30	1-60	1-60	1-30	-	-	2-30	1-
Central Sq. - Pine Hill	2-30	1-60	1-60	2-30	-	-	1-60	-
1 Central Sq.-Lib. Tree Mall	2-60	1-60	1-60	1-60	-	-	2-60	-
3 Central Sq.-Goodwin Circle	2-30	1-60	1-50	1-50	-	-	1-60	-
Central Sq. - Lakeside	2-30	1-60	2-30	2-30	-	-	1-30	1-
Central Sq. - Nahant	-30	-180	1-30	1-35	-	-	1-60	-
Lynn-Boston via Lynnway	5-15	2-30	2-30	6-15	1-60	1-60	2-30	1-
Lynn-Marblehead via Parad.	2-30	1-60	1-60	2-30	-	-	1-60	-
Lynn-Marblehead via Humph.	1-30	1-60	1-60	2-30	1-60	1-60	1-60	-
Salem-Boston via Westn Ave	9-15	1-60	1-60	9-10	1-90	-	2-60	-
5 Salem - North Beverly	1-35	1-60	1-60	2-30	-	-	1-60	-
Salem - Lynn via Loring	2-30	2-30	2-30	2-30	1-60	1-60	3-30	1-
1 Central Sq. - Fay's Estate	2-30	1-X	-	2-30	-	-	-	-
2 Salem Centre-Danvers Sq.	1-	1-120	1-50	1-50	-	-	-	-
3 Salem - Salem Hosp. Loop	-	-180	-	-	-	-	-	-
4 Salem - Danvers Hosp.	1-X	-	-	1-X	-	-	-	-
SCHOOL	12		18					
TOTAL BUSES	67	24	48	61	6	5	28	1

NOTES: H. Headway
V. Vehicles
W. Lynn to Wonderland Shuttle
X. Irregular Headway

LINE STATISTICS

GARAGE: RAIL LINES

DATE: WINTER 1980

		WEEKDAY						WEE
ROUTE NO.	TERMINII	A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	SAT.P V.H.
	RESERVOIR STATION							
10	Bos.Coll.Lechmere-Comm. Ave.	18T-5/6	-	18T-6	19T-6	-	-	14T-7
12	Bos.Coll.Gov't Cntr via Comm.	-	13T-7	-	-	11S-8	10S-10	-
0	Cleveland Cir.-Lechmere	13T-7	13T-7	13T-7	14T-7	8S-10	8S-10	13T-7
1	Riverside - North Station	15T-8	10T-10	16T-7	16T-7/8	10S-10	10S-10	18S-6
	Boston College R.A.D.							
	Riverside R.A.D.							
(L)	Northeastern R.A.D.	4S	4S	4S	4S	2S	2S	3S
7 Ⓑ	Blandford - R.A.D.	3S	3S	3S	3S	-	-	3S
	TOTAL CARS	99	79	101	105	31	30	78
	ARBORWAY STATION							
33	Heath St. - Park St.	8S-8	-	5S-12	5S-12	-	-	-
93	Arborway - Park St.	14T-6	10T-8	13T-8	13T-8	9S-9	6S-12	10T-9
	TOTAL CARS	36	20	31	31	9	6	20
	MATTAPAN STATION							
99	Mattapan - Ashmont	9S-3	3S-8	5S-5	7S-4	2S-15	2S-15	3S-8
	TOTAL CARS	9	3	5	7	2	2	3
	ORANGE LINE							
1-902	Oak Grove - Forest Hills	16F-5	9F-8/8/9	9F-8/8/9	16F-5	5T-15	5T-15	9F-8/9
	TOTAL CARS	64	36	36	64	10	10	36
	RED LINE							
35-936	Harvard/Brattle-Ashmont	11F-6/7	7F-10	7F-10	12F-6	4T-17	4T-17	9T-7/
37-938	Harvard / Brattle - Quincy	11F-6/7	7F-10	7F-10	12F-6	4T-17	4T-17	9T-7/
	TOTAL CARS	88	56	56	96	16	16	36
	BLUE LINE							
6-47	Wonderland - Bowdoin	10F-5	6F-7/8	6F-7/8	11F-4/5	5T-11	4T-11	6F-7
	TOTAL CARS	40	24	24	44	10	8	24

NOTES: H. Headway	S-Single Car
V. Vehicles	T-Two Cars
RAD. Run as directed	K-Three Cars
	F-Four Cars

LINE STATISTICS

GARAGE: VEHICLE RECAP

DATE: WINTER 1980

TERMINII	WEEKDAY						WEEKEND	
	A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	SAT.PEAK V.H.	SUN PEA V.H
BUSES								
Albany	111	31	71	107	6	1	–	–
Cabot	127	60	110	109	33	31	94	47
Arborway	121	45	115	95	18	15	47	17
Somerville	98	43	94	91	22	17	44	20
Fellsway	65	27	50	51	–	–	–	–
Charlestown	80	29	60	63	21	17	56	35
Eagle St. *	37	23	40	29	8	8	21	
Lynn	67	25	48	61	6	5	28	11
Quincy	69	25	69	55	9	9	25	9
Total *	778	308	659	661	123	103	315	139
Trackless Trolley (Total)	34	13	24	28	3	3	14	
STREET CARS								
Reservoir #	99	79	101	105	31	30	78	34
Arborway	36	20	31	31	9	6	20	11
Mattapan	9	3	5	7	2	2	3	2
Total Street Cars	144	102	137	143	42	38	101	47
Rapid Transit Lines								
Orange Line	64	36	36	64	10	10	36	10
Red Line #	88	56	56	96	16	16	36	16
Blue Line #	40	24	24	44	10	8	24	12
Total Rapid Transit	192	116	116	204	36	34	96	38

ES: H. Headway
V. Vehicles
* 2-4 Hour is Peak
# P.M. is Peak

GARAGE: CABOT

LINE STATISTICS

DATE: SPRING 1982

		WEEKDAY						W
ROUTE NO.	TERMINALS	A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	SA PE V.
01.3	Harvard - Dudley	11-6	7-9	11-7	12-6/7	4-15	3-20	7-
06&06.2	Army Base-So Station&Haymarket	3-15	-	3-15	3-15	-	-	-
07	City Point-Franklin & Arch	4-12	A	1-X	3-15	1-40	-	2-
08.7	Columbia Point - Dudley	2-22	2-30	2-30	2-30	1-40	1-40	1-
09.4	City Point & Copley + 09	7-8	4-15	7-10	7-9	1-40	1-40	3-
10	City Point - Dudley	3-20	1-60	2-30	3-22	1-50	1-50	1-
11.8	City Point-Essex & Wash via Bay View	10-6	4-15	9-8	9-8	1-40	1-37	5-
15	Kane Square - Dudley	4-7/8	2-15	3-12	4-9	1-38	1-40	3-
16	Franklin Park - Andrew	2-17	1-30	2-17	2-17	1-30	1-30	2-
17	Fields Corner - Andrew	3-14	1-45	4-12	4-12	-	-	2-
18	Ashmont - Andrew	1-60	1-60	1-60	1-60	-	-	-
19	Fields Corner-Dudley Station	2-20	-	-	2-20	-	-	-
22	Ashmont-Dudley via Talbot	7-8	4-13	5-11	6-9	3-22	2-30	5-
23	Ashmont-Dudley via Washington	9-6	4-13	7-7/8	7-7/8	3-20	1-30	5-
43.1	Egleston-Park & Tremont	8-8	5-12	7-9	8-8	1-60	1-50	4-
44	Seaver & Dudley	2-12	1-24	3-12	3-9	1-30	1-30	1-
45.1	Franklin Park - Dudley	4-8	3-12	4-10	4-10	1-30	1-30	3-
47.2	Central Square - Cambridge - Boston City Hospital	8-10	4-20	7-12	7-12	2-30	1-60	4-
49.7	Northampton-Essex & Wash	1-50	1-50	1-50	1-50	-	-	1-
55	Queensberry - Copley	1-25	1-30	1-30	1-30	1-30	1-30	1-
57	Watertown - Kenmore	A	A	A	A	4-15	4-15	9-
60	Chestnut Hill - Kenmore	A	A	A	A	1-60	1-45	2-
65	Brighton Center - Kenmore	A	A	A	A	-	-	2-
66	Allston - Dudley	8-7/8	4-15	8-10	8-8/9	2-28	1-60	5-
68.1	City Hospital - Copley	1-30	1-30	1-30	1-35	-	-	-
304.3	Watertown-Federal&Franklin	A	A	A	A	-	-	4-
310	Needham Jct-Federal&Franklin	A	A	A	A	-	-	2-
520.1	Roberts & Newton Corner	A	A	A	A	-	-	2-
521.2	Waverley - Newton Corner	A	A	A	A	-	-	1-
522.2	Waltham Hld - Newton Corner	A	A	A	A	-	-	1-
527.1	Auburndale - Newton Corner	A	A	A	A	-	-	1-
532	Needham Junction-Watertown	A	A	A	A	-	-	2-
	Schools	5						
R.A.D.	Run as Directed Dudley Lower	1-X	-	-	-	-	-	-
	TOTAL	107	51	89	98	30	23	8

NOTES: H. Headway
V. Vehicles
A. Operated from Albany
X. Irregular Service

LINE STATISTICS

GARAGE: ALBANY

DATE: SPRING 1982

TERMINALS	WEEKDAY						WEEKEND	
	A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	SAT PEAK V.H.	SU PE V.
City Pt - Mary McCormack H.	-	1-60	1-60	-	-	-	-	-
City Point-Franklin & Arch	-	3-20	3-20	1-X	-	-	-	-
Watertown - Kenmore	11-6	7-9	11-8	12-6	C	C	C	C
Chestnut Hill - Kenmore	5-20	2-30	3-16	5-25	2-30	C	C	C
Brighton Center - Kenmore	3-20	2-30	3-23	3-25	C	C	C	C
Northwest Ind - Dudley	1-30	-	-	1-X				
Riverside-Federal & Franklin	13-4	-	1-30	13-3/4				
Brighton Ctr-Federal & Frank	9-6	-	-	2-20				
Brighton Ctr-Federal & Frank	-	-	3-15	6-5				
Watertown - Copley Square	4-12	-	1-X	4-12	-	-	-	-
Watertown-Federal & Franklin	15-7/8	4-15	6-10	13-4	-	-	C	-
Waltham - Federal & Franklin	8-10	-	4-20	8-10	-	-	-	-
Needham Jct-Federal & Frank	20-5	2-60	3-30	18-5	1-100	1-X	C	-
Roslindale Sq-Copley Shuttle	3-30	-	-	3-30	-	-	-	-
Roberts - Newton Corner	2-40	2-60	2-60	1-60	-	-	C	-
Waverley-Newton Corner	1-60	1-60	1-60	2-60	-	-	C	-
Waltham Hld-Newton Corner	1-60	1-60	2-30	1-60	-	-	C	-
Auburndale - Newton Corner	1-60	1-60	1-60	1-70	-	-	C	-
Needham Junction-Watertown	3-30	3-30	3-30	3-30	-	-	C	-
Schools			3					
TOTAL	100	29	51	97	3	1		

ES: H. Headway
V. Vehicles

GARAGE: ARBORWAY

LINE STATISTICS

DATE: SPRING 1982

ROUTE NO.	TERMINALS	WEEKDAY A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	S P V
21.1	Ashmont-Forest Hills	2-22	1-45	2-25	2-25	-	-	
24	Wakefield Ave - Mattapan	2-20	1-40	2-25	2-25	1-60	1-60	1
26.1	Ashmont-Ashmont-Norfolk-Wash	4-9	1-30	2-15	4-15	1-30	1-30	2
27	Mattapan - Ashmont	1-30	1-30	1-30	1-30	-30	-30	1
29	Mattapan - Egleston	10-5	5-12	8-8	10-5	3-15	3-15	5
30.1	Mattapan - Roslindale	2-20	1-30	2-20	2-20	1-60	1-60	1
32	Cleary Square - Arborway	7-6/7	-20	-20	7-6/7	-60	-60	
32.1	Wolcott Square - Arborway	-20	3-20	5-20	-20	1-60	1-60	4
33.5	River & Milton St - Mattapan	2-30	1-60	2-30	2-30	-	-	1
34	Dedham Line - Arborway	7-7	3-30	4-15	10-6	-60	-60	6
34.7.8	East Walpole - Arborway	9-15	4-30	4-30	6-15	1-60	1-60	1
35.1	Stimson & Wash - Arborway	3-18	2-30	2-30	4-12	-60	-	1
36.8	Charles River Loop-Arborway	6-9	2-30	2-30	5-12	1-60	1-60	4
37	Baker & Vermont - Arborway	3-18	2-30	2-30	4-12	-	-	2
38.3	Wren St-Forest Hills Station	2-22	1-40	2-22	2-22	-	-180	1
39	Arborway - Copley Square	27-3	13-5	21-4	21-4	6-10	3-30	13
40	Georgetown - Arborway	1-50	-30	2-25	2-25	-	-	1
41	Center & Eliot - Dudley	3-12	1-34	2-20	2-20	1-30	-	1
42.1	Arborway-Dudley via Wash St	2-20	2-20	2-20	2-20	1-40	-	2
46	Heath & So Huntington-Dudley	1-30	1-30	1-30	1-30	-	-	1
48	Center & Eliot-Jamaica Plain Loop	-	1-30	1-30	-	-	-	1
50	Cleary Square - Arborway	2-25	1-60	2-25	2-25	-	-	1
51	Cleveland Circle - Arborway	4-18	1-60	4-18	4-18	1-120	-	1
52.1.2	Dedham Mall - Watertown	3-30	2-45	2-45	2-45	-	-	@ 1
	Schools	17		27				
	TOTAL	120	50	104	97	18	12	5

NOTES: H. Headway
V. Vehicles
@. Oak Hill - Newton Center
X. Irregular Service

LINE STATISTICS

GARAGE: BENNETT

DATE: SPRING 1982

TERMINALS	WEEKDAY A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	WEEKEND SAT PEAK V.H.	S P V
Cleveland Circle-Central Sq	3-20	2-30	3-20	3-20	1-60	1-60	1-60	-
Oak Square - Central Square	3-20	2-30	3-20	3-20	-	-	1-60	-
Harvard Sq - Lechmere	2-20	2-20	3-15	3-15	-60	-60	2-20	-
Watertown - Harvard/Brattle	6-7/8	3-15	4-11	6-7/8	2-30	2-30	3-15	1-
Waverley - Harvard/Brattle	-	-	-	-	1-30	1-30	3-15	1-
Belmont Ctr-Harvard/Brattle	3-15	2-30	4-15	4-13/14	1-60	1-40	2-30	-
Arl Hts - Harvard/Brattle	27-3	7-10	12-6	22-4	7-10	6-12	12-7	3-
Arl Center - Harvard/Brattle	-	-	-	-	-	-	-	-
North Camb - Harvard/Brattle	-	-	-	-	-	-	-	-
Park Circle - Harvard/Brattle	4-14	-	2-15	4-15	-	-	-	-
Arlmont-Harv/Bra via Park Cir	-	2-30	2-30	-	1-60	1-60	2-30	1-
Rindge Ave - Central Square	6-10	2-30	4-15	5-13	1-60	1-60	2-25	1-
Arlmont-Harv/Bra via Park Cir	4-17	-	3-25	4-20	-	-	-	-
Spring Hill - Kendall	1-30	1-40	1-40	1-40	-	-	-	-
Sull Sta-Union Sq All via Harv Square	5-15	3-30	5-15	5-15	1-60	1-60	2-35	-
Clarendon Hill - Lechmere	5-11	2-20	4-15	5-11	1-60	1-60	2-20	1-
Clarendon Hill - Lechmere	11-5/6	3-20	4-15	7-8	1-60	1-60	3-20	-
Lexington & Trapello/Cent Camb	-	-	-	-	-	-	2-60	
Cedarwood - Central Sq. Camb	5-20	4-30	6-20	6-20	1-60	1-60	2-60	
Lexington - Waltham	1-65	1-65	1-70	1-70	-	-	-	
Hanscom Air Base - Harv/Bra	5-30	2-60	2-60	4-30	-	-	-	
Hanscom Air Base - Arl Heights	-	-	-	-	-	-	1-60	-
Arl Heights-Bedford V.A. Hos	1-60	1-60	1-60	2-60	-	-	1-60	-
Five Forks - Arlington Center	1-60	-	1-60	1-65	-	-	-	
Schools	3		17					
TOTAL	96	39	82	86	18	17	41	9
TRACKLESS TROLLEY								
Huron Ave-Camb/Common	2-15	1-30	1-30	2-15	-	-	-	-
Waverley - Harvard/Brattle	11-4	3-15	4-11	10-4/5	B	B	B	B
No Camb - Camb/Common	6-5	3-10	4-9	5-7	-	-	B	-
TOTAL TRACKLESS TROLLEY	19	7	9	17				

ES: H. Headway
V. Vehicles
B. Bus instead of T.T.

S & SCHEDULES DEPT.

GARAGE: CHARLESTOWN

LINE STATISTICS

DATE: SPRING 1982

		WEEKDAY						W
ROUTE NO.	TERMINALS	A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	SA PE V.
80	Arlington Center - Lechmere	7-10	3-22	5-12	6-12	1-60	1-60	3-
89	Clarendon Hill - Sullivan	7-4	2-30	4-15	8-8	1-60	1-60	2-
90	Davis Sq-Wellington via Assembly Mall	-	1-60	1-60	1-60	1-60	-	1-
91	Sullivan Sq-Central Square	4-12	3-20	3-15	3-15	1-60	1-60	2-
92.3	Sull-Franklin & Wash via Main	3-15	2-30	2-15	3-15	1-60	-	2-
93.6	Sull-Franklin&Wash via Bunker Hill	9-6	3-20	3-15	8-7	2-30	-60	3-
95	West Medford - Sullivan	F	F	F	F	1-60	1-60	1-
96.8	Med-Harv/Bra via George St	F	F	F	F	2-60	1-60	5-
99.9	Upper Highland - Wellington	F	F	F	F	1-60	-	2-
100.3	Elm Street - Wellington	F	F	F	F	-60	1-60	1-
101.4	Salem Street - Sullivan	F	2-30	F	F	1-60	-60	2-
104.1	Malden Sq-Sullivan via Ferry	4-13	3-20	4-20	4-15	1-60	1-60	2-
105.1	Malden-Sull via Faulkner	2-30	1-60	1-60	2-35	-	-	1-
106	Lebanon-Well via Malden Sta	F	F	F	F	1-60	1-60	3-
108.6	Linden-Well via Malden Sta	F	F	F	F	1-60	1-60	3-
109.1	Linden-Sull via Everett	4-13	3-20	3-20	4-15	1-60	1-60	1-
110	Wonderland-Well via Woodlawn	5-14	2-30	3-20	5-15	1-60	1-60	2-
111.5	Woodlawn - Haymarket Square	10-5	3-20	5-7/8	9-6	1-60	1-60	3-
112.6	Everett Sq Wood Island via Mystic Mall	1-45	1-60	1-60	1-60	-	-	1-
131.1	Melrose -Highland - Malden	2-30	1-X	1-60	2-30	-	-	-
131.2	Melrose-Highland-Mal via Main	-	-	1-X	-	-	-	-
131.4	Main&Porter-Mal Sta via E Side	-	-	-	1-X	-	-	-
134.7	Medford Square - Wellington	F	-	-	F	1-60	1-60	2-
135.5	Wakefield Sq - Malden Station	1-60	-30	1-105	3-30	-	-	-
136.5	Reading-Malden via Lakeside	2-60	2-60	1-60	1-65	-	-	2-
137.3	Reading Square-Malden Station	1-60	1-60	2-75	-	-	-	-
137.4	Reading Sq-Mal Sta via Am Mut	-	-	-	-X	-	-	-
700	Burlington - Haymarket	7-10	2-60	4-45	5-25	1-120	1-120	1-
700.9	Burlington-Arlington Center	1-X	-	1-X	-	-	-	-
701	Burl Line-Park Sq via Wob Sq & I-93	2-75	-	-	-	-	-	-
701.1	Burl Line-Park Sq Mass Pike	-	-	-	2-26	-	-	-
701.2	Woburn Sq-Haymarket via I-93	1-X	-	-	1-X	-	-	-
701.3	Burl Line-Copley via 128&I-93	5-10	-	-	-	-	-	-
701.4	Burl Line-Haymarket via I-93	-	-	1-X	9-10	-	-	-
701.5	Woburn Square - Park Square	2-30	-	-	-	-	-	-
701.7	Burl Mall-Haymarket 128&I-93	2-X	-	-	-	-	-	-
701.8	Burlington-Haymarket via 128	-	-	-	1-X	-	-	-
701.9	Burl Industrial-Hay 128&I-93	1-X	-	1-X	-	-	-	-
	Schools	10		16				
	TOTALS	93	35	64	79	20	14	45

NOTES:
H. Headway
V. Vehicles
F. Fellsway

GARAGE: FELLSWAY

LINE STATISTICS

DATE: SPRING 1982

	WEEKDAY						WEEKEND	
TERMINALS	A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	SAT PEAK V.H.	SU PE V.
West Medford-Sullivan	5-12	2-30	3-20	3-20	C	C	C	C
Medford Sq.-Harvard/Brattle	10-8	3-30	8-15	11-8	C	C	C	C
Malden - Wellington via Comm.	1-50	1-50	1-50	1-50	-	-	-	-
Upper Highland-Wellington	4-15	2-30	3-20	3-20	C	C	-	-
Elm St-Wellington	2-20	2-20	2-20	2-20	C	C	C	
Salem Street - Sullivan	4-15	-	-	-	C	C	C	
Malden Station - Sullivan	4-15	-	6-13	9-8	-	-	-	-
Lebanon - Wellington	4-15	2-30	4-20	4-20	C	C	C	
Linden - Wellington	3-23	2-30	4-20	3-20	C	C	C	
No. Woburn - Wellington	2-60	2-60	1-60	2-60	-	-	C	-
Winthrop St- Wellington	1-60	1-60	1-60	1-60	-	-	C	-
Medford Sq - Wellington	1-30	-	-	1-30	C	C	C	
Elm St - Haymarket	3-13	-	2-15	4-15	-	-	-	-
West Medford - Haymarket	4-13	-	2-15	4-15	-	-	-	-
Run as Directed	-	-	1-X	-	-	-	-	
Schools	10		14					
TOTAL	58	17	52	48				

OTES: H. Headway
V. Vehicles
C. Charlestown

LINE STATISTICS

GARAGE: QUINCY

DATE: SPRING 1982

		WEEKDAY						W
ROUTE NO.	TERMINALS	A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	SA PE V.
20	Fields Corner-Neponset & Adams	-	1-30	1-30	1-30	1-30	1-30	1-
20.2	Fields Corner-Adams & Hallett	-	-	-	2-15	-	-	-
20.4	Fields Corner - Hallett	1-30	-	-	-	-	-	-
20.7	Gall Blvd-Fields Cor via Adams	2-12	-	-	-	-	-	-
20.9	Fields Cor-Fields Cor via Adam	-	1-30	2-30	-	-	-	1-
210	Quincy-No Quincy via Hancock	-	1-30	-	-	-	-	1-
210.3	Quincy - Fields Corner	2-30	-	2-30	2-30	-	-	-
211	Quincy - Squantum	2-30	1-60	2-30	2-30	-	-	1-
212.2	Quincy Station-No Quincy	-30	-60	-30	-60	-	-	-
214.1	Quincy - Germantown	4-10	1-30	3-20	2-20	-	-	1-
215.1	Quincy-Ashmont via W. Quincy	3-20	2-30	3-30	4-30	1-60	1-60	2-
216.2	Quincy - Houghs Neck	4-10	2-30	3-20	2-20	1-60	1-60	2-
217	Wollaston - Ashmont	2-30	1-60	1-60	2-30	-	-	1-
220	Quincy Center Sta-Hingham	-	1-60	-	-	1-60	1-60	1-
220.1	Quincy - Hingham	6-10	1-60	3-20	7-10	-	-	1-
221	Quincy - Fort Point	-X	-	-X	1-X	-	-	-
222	Quincy - East Weymouth	6-11	2-30	4-30	6-10	1-60	1-60	2-
225.1	Quincy-Wey via Desmoines	9-20	1-60	3-20	3-20	1-60	1-120	1-
225.4	Quincy Cent-Weymouth Landing	-20	1-60	2-20	2-20	-	-	1-
230.3	Quincy Center-Brockton Line via Braintree Sta.	4-20	2-60	2-60	4-20	1-60	1-60	2-
236.2	Quincy Center-South Shore Plaza via Braintree Sta.	1-60	2-60	2-60	3-30	-	-	1-
238	Quincy Cent-Crawford Square	3-30	1-60	1-60	3-30	1-60	1-60	2-
240.1	Crawford Square-Ashmont	6-10	2-30	3-30	6-10	1-60	1-60	2-
245.4	Quincy-Mattapan via E. Milton	2-30	1-60	1-60	3-30	-	-	1-
	Schools	12		19				
	TOTAL	69	24	57	55	9	9	24

NOTES: H. Headway
V. Vehicles
X. Irregular Service

LINE STATISTICS

GARAGE: LYNN

DATE: SPRING 1982

	WEEKDAY						WEEKEND	
TERMINALS	A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	SAT PEAK V.H.	SU PE V.
Wonderland-Marverick-Revere St	5-15	3-30	4-20	4-20	1-60	1-60	3-30	1-
Wonderland-Maverick via Beach	4-15	2-30	3-20	3-20	1-60	1-60	2-30	-
Revere City Hall - Beachmont	2-30	1-60	2-30	2-30	1-40	-	1-60	-
Orient Heights - Maverick	4-14	3-20	4-15	4-15	1-60	1-60	2-30	-
Wood Island - Maverick	1-30	-	-	1-25				
Melrose-Lebanon-Wyoming Sq. via Malden Square	2-30	-60	2-30	2-30	-	-	1-60	-
Wonderland-Orient Hts Shuttle						-25		
Lynn-Boston via Western Ave	5-15	3-30	3-30	6-15	1-60	1-60	3-30	1-
Northgate - Revere House	-	1-60	-	-				
Lynn-Boston via Cliftondale	12-8	2-60	4-30	11-10	1-80	1-80	2-60	1-
Cent Sq-No Saugus via Myrtle	2-30	1-60	2-30	2-30	-	-	1-60	-
Saugus - Malden	2-35	1-60	2-45	2-45	-	-	1-60	-
Granada Hlds - Malden Station	1-35	1-60	1-40	1-40				
Central Square - Pine Hill	2-30	-	-	1-40				
Central Sq-Danvers Sq via Mall	-	2-60	2-60	1-60	-	-	2-60	-
Central Sq - Goodwin Circle	2-30	1-60	2-30	2-30	-	-	1-60	-
Cent Sq - Lakeside via Eastern	2-30	1-60	2-30	2-30	-	-	1-60	-
Central Square - Nahant	1-30	-	-	1-40				
Lynn-Boston via Lynnway	7-15	2-30	3-30	7-15	1-60	1-60	2-30	-
Lynn-Marblehead via Paradise	2-30	1-60	1-60	2-30	-	-	1-60	-
Lynn-Marblehead via Humphrey	2-30	1-60	1-60	2-30	1-60	1-60	1-60	1-
Salem-Boston via Western Ave	11-15	2-60	1-60	10-10	1-90	-	2-60	-
Salem - North Beverly	1-60	1-60	1-60	1-60	-	-	1-60	-
Salem - Lynn via Loring Ave	2-30	2-30	2-30	2-30	1-60	1-60	2-30	-
Salem - Danvers Square	1-X	1-60	1-50	1-50	-	-	-	-
Salem - Danvers Hospital	1-60		1-X	1-X				
Run as Directed	1-X			1-X				
Schools	6		10					
TOTAL	81	32	54	72	10	8	29	6

ES: H. Headway
V. Vehicles

GARAGE: RAIL LINES

LINE STATISTICS

DATE: SPRING 1982

		WEEKDAY						W
ROUTE NO.	TERMINALS	A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	SA PE V.H
	RESERVOIR STATION							
311	Boston College-North Station	30S-3/4	20S-5	30S-3/4	30S-3/4	10S-10	10S-10	20S
333	Cleveland Circle - Park Street	14T-6	8T-10	14T-6	14T-6	7S-10	5S-10	8T
350	Riverside - Lechmere	17T-6/7	11T-10	15T-7/8	15T-7/8	11S-10	11S-10	11T
NBL)	Northeastern R.A.D.	6S	8S	8S	6S	4S	4S	6S
(B)	Blandford - R.A.D.	-	-	-	4S	4S	4S	4S
	Riverside - R.A.D.	-	-	-	-	-	-	
	Boston College - R.A.D.	-	-	-	-	-	-	
	TOTAL CARS	98	66	96	98	36	34	68
	ARBORWAY STATION	Buses are replacing Rail Service on Arborway Line						
	MATTAPAN STATION							
399	Mattapan - Ashmont	6S-4	3S-8	5S-5	6S-4	2S-12	2S-12	3S
	TOTAL CARS	6	3	5	6	2	2	3
	ORANGE LINE							
01-02	Oak Grove - Forest Hills	18F-4	10F-7/8	10F-7/8	18F-4	6T-12	6T-12	10F
	TOTAL CARS	72	40	40	72	12	12	40
	RED LINE							
35-36	Harvard/Brattle - Ashmont	12F-6	7F10/11	7F10/11	12F-6	6T-12	6T-12	7F
RAD	Run as Directed	1F-X			1F-X			
39-40	Harvard/Brattle- Braintree	14F-6	8F10/11	8F10/11	14F-6	7T-12	7T-12	8F
RAD	Run as Directed	2J-X			1J-X			
	TOTAL CARS	118	60	60	113	26	26	60
	BLUE LINE							
946-47	Wonderland-Gov't Center	11F-4	6F7/8	6F7/8	11F-4	5T-11	4T-11	6F
	TOTAL CARS	44	24	24	44	10	8	24

NOTES: H. Headway
V. Vehicles
X. Irregular Headway

S-Single Car
T-Two Cars
K-Three Cars
F-Four Cars
J-Five Cars

LINE STATISTICS

GARAGE: VEHICLE RECAP

DATE: SPRING 1982

TERMINALS	WEEKDAY A.M. V.H.	BASE V.H.	2-4 V.H.	P.M. V.H.	8-10 V.H.	LATE V.H.	WEEKEND SAT PEAK V.H.	SUN PEAK V.H.
Albany	100	29	51	97	3	1	–	–
Cabot	107	51	89	98	30	23	81	21
Arborway *	120	50	104	97	18	12	52	10
Somerville	96	39	82	86	18	17	41	9
Fellsway	58	17	52	48	–	–	–	–
Charlestown	93	35	64	79	20	14	45	11
Lynn	81	32	54	72	10	8	29	6
Quincy	69	24	57	55	9	9	24	5
TOTAL	724	277	553	632	108	84	272	62
Trackless Trolley (Total)	19	7	9	17				
STREET CARS								
Reservoir	98	66	96	98	36	34	68	35
Arborway *	–	–	–	–	–	–	–	–
Mattapan	6	3	5	6	2	2	3	2
TOTAL STREET CARS	104	69	101	104	38	36	71	37
RAPID TRANSIT LINES								
Orange Line	72	40	40	72	12	12	40	14
Red Line	118	60	60	113	26	26	60	26
Blue Line	44	24	24	44	10	8	24	8
TOTAL RAPID TRANSIT	234	124	124	229	48	46	124	48

S: H. Headway
V. Vehicles
*. Buses Replacing Rail Service

S & SCHEDULES DEPT.

APPENDIX C - 3 : Estimated Theoretical Operating Capacities and Estimates for Normal and Crush Capacities.

APPENDIX C - 3: Operating Capacities

The theoretical operating capacity of a rail transit system, defined as the number of passenger spaces provided through a given point during a specified period of time, is dependent upon the size of the transit cars and the train length, the schedule these trains adhere to, and the operation variance from the schedule. Thus, in computing line capacity, three major areas have been addressed:

- Train Capacity: length of train and car capacity.
- Schedule
- Operations

Train Capacity. Train capacity is computed by multiplying train car constraint (number of cars per train) by car capacity.

- Length of train: The maximum number of cars per train is constrained by the platform length. Currently, platforms are of sufficient length on all of the MBTA rapid rail lines to accommodate 4-car trains. On the Orange and Red Lines, the station spacing is sufficient to permit lengthening of platforms to accommodate 6-car trains.

- Car capacity: Is calculated by adding the number of seats to the number of standee spaces. Standee spaces are computed by dividing the floor space available for standing by the space per standee. Different measures have been used for space per standee with the ultimate choice one of policy and judgement. Figures used in the past have ranged from 2.5 square feet to 1.5 square feet per standee. 2.5 square feet generally reflects a comfortable amount of standing room with sufficient area to move unhindered into and out of a vehicle. At loadings greater than this, passengers may have difficulty boarding a vehicle. One and one-half square feet has been used as a design load; that is, the equipment has been designed to accommodate the weight of passengers if there were one on every 1.5 square feet of available floor space. Observations of the maximum or "crush" load on transit vehicles indicates that 1.75 square feet most reasonably reflects the maximum standing capacity of a vehicle. For the purpose of these estimates, 2.5 square feet per standee has been used to reflect a "normal" load and 1.75 square feet has been used to reflect a "crush" load.

Schedule. To compute line capacity requires multiplication of train capacity times the number of trains passing one point on the line in a given period of time.

- Frequency: The schedule is constrained by the maximum frequency at which trains can be operated. This is determined by signal system design and the tolerances for operating variances from schedule. The signal system for each of the MBTA's rapid rail lines is designed to accommodate trains at 90-second intervals.

However, scheduling trains at 90-second intervals would provide no room for variance from the schedule which normally occurs. Also, the time spent loading and unloading passengers can vary from train to train depending upon the flow of passengers through the system.

It is estimated that the variance from scheduled headway can reasonably range from plus or minus 1/2 to plus or minus 1 minute under normal operating conditions. As a result, the greatest potential train frequency which can be operated on the rapid rail lines ranges from 2 minutes (90-second design limit plus 30-second variance) to 2 1/2 minutes (90-second design plus 1 minute variance). For the purpose of these capacity estimates, a maximum potential train frequency of 2 minutes has been assumed.

- Equipment: The scheduled frequency is further constrained by the number of cars available for scheduled operation. The maximum frequency as constrained by existing fleet is determined by taking 85% of the active fleet (15% of the fleet is assumed to be held in reserve or being maintained) and dividing by the train constraint will yield the number of trains available. The number of trains is in turn divided into the time required to make one round trip (including the time to turn the train) or the "allowed" time.

Operations. The line capacity is further impacted by the operational variances from headway. That is, if trains are scheduled at three-minute intervals in response to market demand, and if one train operates one minute ahead of schedule, a portion (1/3) of the train's capacity will not be "effectively" utilized. If passengers arrive at station platforms in a uniform temporal distribution, trains arriving at close intervals will not be filled and trains arriving at long intervals will be overloaded.

To reflect the impact of operational variance from scheduled frequenc in the capacity estimate, a factor has been included in the calculations to indicate the percentage of train capacity which can be effectively utilized with a variance of plus or minus 1/2 minute from scheduled frequency. The effective capacity factor used in these calculations accounts for the number of passenger spaces which go unfilled because of trains operating ahead of schedule and the number of passengers who are riding in excess of the train loading standard.

The following four pages provide a line-by-line summary of the results of proceeding methodology. This is shown for normal and crush loads under actual, constrained, potential, and design conditio and provides a summary of theoretical operating capacity for the MBTA rapid transit system. The definitions of capacity types used for making assumptions are as follows:

1. Actual Capacity.--Reflects the estimated line capacity given present service schedules.

2. Constrained Capacity.--The number of passengers accommodated with the maximum amount of service which can be provided given the existing vehicle fleet.

3. Potential Capacity.--The number of people that can be carried with an unlimited fleet and station modifications necessary to accommodate such a fleet.

4. Design Capacity.--The maximum capacity possible given the design limitations of the signal system and assuming scheduled 90-second frequencies.

RED LINE "HYBRID" CAR

A) # SEATS/CAR 58

B) STANDEE SPACE 324 sq. ft.

C) STANDEE CAPACITY

Normal load @ 2.5 sq. ft.	129	Crush load @ 1.75 sq. ft.	186

D) TOTAL PASSENGERS/CAR

Normal load	187	Crush load	244

E) TRAIN CAPACITY

@ existing 4 cars		@ potential 6 cars	
Normal load	748	Normal load	1,122
Crush load	976	Crush load	1,464

ACTIVE FLEET 164 PEAK REQ'T 114 (26F + 2 Five)

ALLOWED TRIP TIME 78 minutes

CONSTRAINT (15% of Active Fleet) 140 (35F)

				CONSTRAINT (with·current fl	
TRAIN FREQUENCY	ACTUAL	POTENTIAL	DESIGN	4 cars/train	6 cars/tra
headway (minutes)	3.0	2.0	1.5	2.2	3.4
# trains/hour	20	30	40	27	18
effective capacity	.85	.78	.71	.80	.87

	NORMAL LOAD		CRUSH LOAD	
	@ 4 Cars	@ 6 Cars	@ 4 Cars	@ 6 Cars
ACTUAL	12,716	19,074	16,592	24,888
POTENTIAL	17,503	26,255	22,838	34,258
DESIGN	21,243	31,865	27,718	41,578
CONSTRAINT	16,157	19,571	21,082	22,926

ABSOLUTE THEORETICAL CAPACITY

NORMAL LOAD		CRUSH LOAD	
@ 4 Cars	@ 6 Cars	@ 4 Cars	@ 6 Cars
29,920	44,880	39,040	58,560

CURRENT ESTIMATED PEAK HOUR VOLUME 15,000 (3/82)

ORANGE LINE

#2 MAIN

A) # SEATS/CAR 58

B) STANDEE SPACE 243 sq. ft.

C) STANDEE CAPACITY

Normal load @ 2.5 sq. ft.	97	Crush load @ 1.75 sq. ft.	139

D) TOTAL PASSENGERS/CAR

Normal load	155	Crush load	197

E) TRAIN CAPACITY

@ existing 4 cars		@ potential 6 cars	
Normal load	620	Normal load	930
Crush load	788	Crush load	1,192

ACTIVE FLEET 120 PEAK REQ'T 68 (17F)

ALLOWED TRIP TIME 77 minutes

CONSTRAINT (15% of Active Fleet) 102(25F)

TRAIN FREQUENCY	ACTUAL	POTENTIAL	DESIGN	CONSTRAINT (with current fleet) 4 cars/train	6 cars/train
headway (minutes)	4.5	2.0	1.5	3.1	4.5
# trains/hour	13	30	40	19	13
effective capacity	.89	.78	.71	.85	.89

	NORMAL LOAD @ 4 Cars	@ 6 Cars	CRUSH LOAD @ 4 Cars	@ 6 Cars
ACTUAL	7,173	10,760	9,117	13,676
POTENTIAL	14,508	21,762	18,439	27,659
DESIGN	17,608	26,412	22,379	33,569
CONSTRAINT	10,013	12,726	10,760	13,676

ABSOLUTE THEORETICAL CAPACITY

NORMAL LOAD @ 4 Cars	@ 6 Cars	CRUSH LOAD @ 4 Cars	@ 6 Cars
24,800	37,200	31,520	47,280

CURRENT ESTIMATED PEAK HOUR VOLUME 7,000 (3/82)

BLUE LINE

#4 EAST BOSTON

A) # SEATS/CAR 42

B) STANDEE SPACE 170 sq. ft.

C) STANDEE CAPACITY

Normal load @ 2.5 sq. ft.	68	Crush load @ 1.75 sq. ft.	97

D) TOTAL PASSENGERS/CAR

Normal load	110	Crush load	139

E) TRAIN CAPACITY 4 CARS

Normal load	440	Crush load	556

ACTIVE FLEET 70

PEAK REQ'T 40 (10F)

ALLOWED TRIP TIME 45 minutes

CONSTRAINT (15% of Active Fleet) 60 (15F)

TRAIN FREQUENCY	ACTUAL	POTENTIAL	SIGNAL DESIGN	CONSTRAINT (with current fle
headway (minutes)	4.5	2.0	1.5	3.5
# trains/hour	13	30	40	20
effective capacity	.80	.78	.71	.85

	NORMAL LOAD	CRUSH LOAD
ACTUAL	5,091	6,432
POTENTIAL	10,296	13,010
DESIGN	12,496	15,790
CONSTRAINT	7,480	9,452

ABSOLUTE THEORETICAL CAPACITY
(@ 4 Cars)

NORMAL LOAD	CRUSH LOAD
17,600	22,239

CURRENT ESTIMATED PEAK HOUR VOLUME 6,000 (3/82)

GREEN LINE "HYBRID" CAR

A) # SEATS/CAR 42 PCC/52 LRV

B) STANDEE SPACE 148 sq. ft. PCC/284 sq. ft. LRV

C) STANDEE CAPACITY

Normal load @ 2.5 sq. ft. 59 PCC/113 LRV

Crush load @ 1.75 sq. ft. 84 PCC/162 LRV

D) TOTAL PASSENGERS CAR

Normal load 101 PCC/165 LRV

Crush load 126 PCC/214 LRV

E) TRAIN CAPACITY

@ existing (Hybrid of 1 LRV/2 PCC)		@ potential (Hybrid of 2 LRV/3 PCC)	
Normal load	174	Normal load	363
Crush load	223	Crush load	449

ACTIVE FLEET 196

PEAK REQ'T 120

ALLOWED TRIP TIME 88

CONSTRAINT (15% of Active Fleet) 167(34T + 99S)

TRAIN FREQUENCY	ACTUAL	POTENTIAL[1]	CONSTRAINT	POTENTIAL[2] HYBRID 3 car PCC 2 car LRV
headway (seconds)	55	30	40	73
# trains/hour	65	120	90	49
effective capacity	.55	.25	.42	.65

	NORMAL LOAD		CRUSH LOAD	
	Existing	Potential	Existing	Potential
ACTUAL	6,221	12,977	7,972	16,052
POTENTIAL	5,220	10,890	6,690	13,470
CONSTRAINT	6,577	11,562	8,429	14,300

ABSOLUTE THEORETICAL CAPACITY

NORMAL LOAD		CRUSH LOAD	
Existing	Potential	Existing	Potential
20,880	43,560	26,760	53,880

CURRENT ESTIMATED PEAK HOUR VOLUME 7,000

---

[1] Potential for currently used cars calculated by creating a "hybrid vehicle" and weighting an average for a 2 car PCC and 1 car LRV.

[2] Potential hybrid car train for future use has a capacity based on weighted average of 3 PCCs and 2 LRVs.

APPENDIX D

Management Rights Act Information (Chapter 581), Executive Performance Evaluation Format

CHAPTER 581

Definition

Chapter 581 of the Acts of 1980 was enacted by the Legislature and signed by the Governor on December 7, 1980. This Chapter is commonly known as the Management Rights Act because it provides MBTA management with the capability to operate the Authority in a manner consistent with normal management prerogatives. These prerogatives, which include most of the major provisions of the Act, include the following:

1. The right to direct, appoint, employ, assign and promote officers, agents and employees.

2. The right to discharge and terminate employees, subject to specific clauses which prohibit such discharge or termination on the basis of race, color, religion, sex, age, national origin, handicapping condition, marital status, political affiliation, or union activities.

3. The right to plan and determine the levels of service provided by the Authority.

4. The right to direct, supervise, control, and evaluate the Authority's departments, units, and programs; as well as the right to classify positions and establish duties and productivity standards.

5. The right to develop and determine levels of staffing and training.

6. The right to determine whether goods or services should be made, leased, contracted for, or purchased on either a temporary or permanent basis.

7. The right to assign and apportion overtime.

8. The right to hire part-time employees.

Other provisions of the Act include, but are not limited to, various items concerning the responsibilities of the Board of Directors, the sale of notes and bonds, and the change in the Authority's budget from a calendar year basis to the State fiscal year as of July 1, 1983.

Due to a union appeal of this legislation, implementation of Chapter 581 did not occur until October 22, 1981 after the Federal Appeals Court affirmed the legality of the Act's provisions.

Management Action

Since implementation began, the MBTA has initiated a number of actions, all of which have had two major objectives: first, to improve service; and second, to reduce expenses, assuming no degradation in the improvement of service efficiency. Examples of these actions include the following.

1. On October 22, 1981, a new policy regarding the allocation of overtime was instituted. This new policy changed the strict seniority-first rule to one which enabled management to select th most capable and available person for the overtime work. The new policy also incorporates a provision which prohibits workers with poor attendance records to be eligible for overtime. During 1981 MBTA management reduced overtime expenditures by $5,803,149, or a reduction in overtime hours of 60%.

2. On October 22, 1981, the Authority stopped the practice of restricting Operators to the assignment of one detail at a time. Operators now can be assigned more than one detail without having return to their originating point, thus increasing the productivi of those employees.

3. On October 22, 1981, the Authority stopped the practice of allowi senior individuals to obtain overtime on night work trains if it resulted in the inability of that individual to work his regularl scheduled work on the next day (six-hour off work rule). This practice had created overtime expenditures to cover individuals n able to perform regularly scheduled work.

4. On October 26, 1981, the MBTA stopped the practice of not allowin "blueprint" cover operator from going to another location to cove vacant run. Old rules prohibited the reassignment of individuals between locations (increased productivity).

5. On October 26, 1981, the Authority abolished a work rule which prohibited a conductor on the second car of a Green Line train fr being reassigned as the Operator of a one-car train (increased productivity).

6. On November 17, 1981, the Authority initiated a series of meeting with the Carmen's Union regarding the work practices within the Authority's money room operation. The meeting resulted in a plan agreed upon by union and management. Based on 1982 year end and February 1983 expenditures, the projected annual savings for the money room is expected to be $201,274.58. This savings has been accomplished by a combination of increased productivity and new equipment (revised 3/18/83).

7. On November 28, 1981, the Authority reassigned car cleaners and shifters on the Green Line to locations and work shifts where man ment determined a need existed. This was accomplished without observing former restrictions requiring bidding for locations and shift times (increased productivity).

8. On November 28, 1981, management established a policy that, if a cleaner on the Green Line was qualified to perform shifter's work would do so if the need existed. Conversely, if a shifter was nc shifting and cleaning work was needed, shifters would be required clean vehicles (increased productivity).

9. On November 28, 1981, the Authority reclassified stock clerks as roving stock clerks. They now may cover more than one location. This action has resulted in increased productivity and a cost avoidance of hiring stock clerks for each location ($30,000 to $60,000 in savings).

10. On November 28, 1981, the Authority reassigned 22 of the 44 individuals who were assigned only to track walking to preventive maintenance and other duties. The remaining 22 track walkers were assigned to cover track based on needs dictated by track reliability data (increased productivity).

11. Starting in November 1981, and on a continuous basis thereafter, the Authority developed specifications for the cleaning of stations, buildings and vehicle interiors. As a result of this work, the Authority has implemented the following contracts.

Contract Area	Amount (Annual Basis)	Contract Start Date	Annual Savings
1. Janitorial Services - All "T" facilities	$674,474.00	6/21/82	$395,530.00
2. Interior Cleaning of Buses - Charlestown, Fellsway and Lynn Garages	276,768.60	6/5/82	157,231.40
3. Interior Cleaning of Buses - Albany, Cabot, Bartlett and Quincy Garages	394,187.60	10/22/82	328,356.60
4. Blue Line Station Cleaning	243,900.00	6/21/82	140,008.00
5. Downtown Station Cleaning - Washington St., Park St., Government Center (Green only) and State St. (Orange only)	309,966.00	11/23/82	204,261.90
6. Green Line (North) Station Cleaning - Haymarket, N. Station, Science Park and Lechmere	117,000.00	12/15/82	52,154.19
7. Red Line Station Cleaning Contract - Charles/MGH, Kendall, Central, Harvard/Holyoke and Harvard/Brattle	103,272.00	12/15/82	129,357.82
8. Green Line Station Cleaning - Boylston, Arlington, Copley, Auditorium, Kenmore Prudential and Symphony	167,328.00	12/15/82	216,973.15

Contract Area	Amount (Annual Basis)	Contract Start Date	Annual Savings
9. Orange Line Station Cleaning - Community College, Sullivan Sq., Wellington, Malden Center & Oak Grove	$90,000.00	12/15/82	$191,243.09
10. Interior Cleaning of Red Line Vehicles	98,354.00	Est. 4/2/83	338,070.95
TOTAL	$2,475,280.20		$2,153,187.10

(Revised 3/18/83)

12. On November 28, 1981, the Authority changed the method of rubbish collecti to enable carhouse and garage personnel to dispose of rubbish into dumpste rather than sending special groups of workers out to pick up trash (increa productivity).

13. On November 28, 1981, the Authority stopped the practice of sending two welders and two grinders on work assignments. Now one welder and one grin will be assigned to accomplish the same work previously done by four employees (increased productivity).

14. On November 28, 1981, the Authority abolished two tool room attendant positions and reassigned the individuals as car cleaners. This avoided approximately $60,000 in labor costs which would have occurred if the vaca car cleaner positions were filled with outside personnel.

15. On December 1, 1981, the Authority reassigned 36 repairmen on the Green Li to locations and shifts as determined by management. This was accomplishe without a re-pick (increased productivity).

16. On December 1, 1981, the Authority resassigned 27 individuals working on L modifications to new shift hours without re-picking (increased productivit

17. The MBTA eliminated the system-wide selection of work by surface operators which was scheduled for 1981. This action will save approximately $85,000 training and retraining costs.

18. The MBTA curtailed the posting and bidding of vacancies which in the past created extensive movement of the work force among the various locations o the Authority. This action will result in a savings of approximately $150,000 associated with training, retraining and administration time.

19. During November, December and January, the Authority held meetings with th Carmen's Union regarding the employment of part-time bus operators. The Union strongly objected to implementation of part-time operators, but the Authority integrated 20 part-time employees into the winter schedule in Quincy. Since then, the employment of part-time operators has continued a more rapid pace than originally anticipated. Eighty part-time operators we added to the summer, 1982 schedule. An additional 120 part-time operators being hired for the fall, 1982 schedule, and 200 more will be added during

1983/FY84. Annualized savings from the hiring of part-time workers may exceed $6 million.

20. The Machinists' Union was advised in two meetings during January and February, 1982, that it is the intention of the Authority to implement part-time fuelers in the automotive area and to combine machinists' classifications in the Everett Shops. The use of a third classification of mechanics to take over fueling tasks, allowing 39 1st and 2nd class mechanics now performing these duties to be reassigned to bus maintenance and repair is now anticipated to start by the fall of 1982. This reassignment will be phased in at all garages over a period of several months. Annual savings to the Authority will be approximately $685,000 based on the lower rate of pay for this third classification. Additionally, increased productivity by reassigning trained mechanics from their fueling duties to bus maintenance is expected.

21. Also accomplished in 1981, either directly by the passage of Chapter 581 or by assistance it afforded, were:

    a. Reduction in the number of "T" employees in 1981 by 609. The annualized savings of this decrease is approximately $21 million.

    b. The contribution required on overtime earnings to the pension fund was abolished. The annualized savings to the Authority based on 1981 overtime would be approximately $515,000.

    c. Abolition of automatic cost-of-living salary adjustments. Savings over the last year is $15 to $20 million.

22. The Authority integrated thirteen part-time gatemen into the summer 1982 schedule. Annualized savings from this action are expected to be approximately $165,000.

23. The Authority placed a system-wide restriction on the internal bidding procedures. All employees must now stay a minimum of two years in a job before they are eligible to bid for a new position. This should increase productivity and reduce the costs normally associated with the constant movement of employees (such as training and administrative costs).

24. Engineering and Maintenance electrical workers have been reassigned and will only be allowed to bid for jobs for which the Authority determines they are qualified. This will increase productivity and decrease training costs.

25. The Authority eliminated the practice of requiring yard motormen to drive tampers out of the yard. Operators now perform this function, eliminating the overtime that was usually paid to yard motormen for this duty.

26. The Authority has changed the normal work week for trackmen to include weekends. This decreases overtime paid for weekend work. It also increases productivity and reduces service interruptions by allowing the Authority to increase the amount of track work done on weekends when fewer vehicles are operating.

27. The practice of having to assign five roofers every time a "kettle" is used has been eliminated, resulting in increased productivity.

28. The Authority is now purchasing, from private companies, fabricated ductwork as necessary. Previously all such work had to be done in the Authority's ow shops.

29. Warranty repair work on buses, which in the past had been performed by Authority personnel, was recently done by representatives of the bus company (Canadian Flyer). This led to an increase in productivity (Authority bus mechanics could continue with their regular duties). This action should also improve the strength of any future claims made under the warranty agreement.

30. The Authority established a new classification and rate of pay for information specialists. By establishing a new classification for this work the Authority avoided higher costs for the work. The information specialist should improve the Authority's ability to deliver information to the public.

31. The Authority has eliminated the practice of automatically assigning switch cleaners to work in pairs over the winter. Whether or not cleaners are assigned in pairs will be determined by management. This will result in an increase in productivity.

32. Engineering and Maintenance crew sizes, which were previously determined by collective bargaining agreement, are now being evaluated and assigned at management's discretion (4-man power line crew, 3-man emergency crew).

33. On May 27, 1982 the Authority signed a one year contract with a private security firm to provide watchmen services at 3 Authority locations. The contract is for $163,501 and is expected to save the Authority $234,083 on a annual basis.

34. On March 10, 1983 the Board of Directors approved a $6 million contract awar for Blue Line Track Improvements. Previous to C.581 this type of work coul not have been awarded to an outside firm.

35. Engineering and Maintenance truck drivers will replace motormen on high spee rail vehicles. This will result in an estimated annual savings of $37,616.

36. Engineering and Maintenance trackmen will begin doing their own rail burning replacing ironworkers who previously did this work. This change of assignment will result in the saving of the equivalent of $87,051 of ironworkers' time to perform other needed duties.

37. The Authority is currently preparing to implement changes in the job responsibilities and the method of assignment of Engineering and Maintenance truck drivers. These changes, which include broadening the truck drivers' responsibilities to include first level maintenance, are estimated to save the Authority $175,909 on an annual basis.

38. Continuing the process begun in November 1981 (see item #11), the contract for the Interior cleaning of Buses at the Charlestown, Fellsway and Lynn Garages was rebid after one year, upon its expiration. The contract was awarded to the low bidder at an annual cost of $282,530.40. This contract,

for the period June 7, 1983 to June 6, 1984 is estimated to save the Authority between $312,219.17 and $396,751.28 on an annual basis.

39. The Authority continued the practice of having an outside security firm provide watchmen services by rebidding this contract after the original one year contract expired (see item #33). The contract, which is for the period May 29, 1983 to May 28, 1984, is for $162,762.96 and is estimated to save the Authority between $270,761.84 and $309,243.93.

CONFIDENTIAL

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

EXECUTIVE PERFORMANCE APPRAISAL

Name of Person Rated ______________________________

Position Title ______________________________ Grade ____________

Department ______________________________

Years of Service ______________ Years in this Position ______________

DIRECTIONS: The purpose of this appraisal is to aid in the development of each individual by affording a means of documenting good performance or identifying areas of performance in which improvement is needed. The form should be completed by the immediate manager or supervisor whose position is evaluated in Grade I through IV, reviewed with the next higher level of supervision for concurrence or guidance, up through the Directorate Head level, then discussed with the person being rated.

RATING SCALE

5.....DISTINGUISHED - Performance that is consistently of exceptional quality. Assigned tasks are completed with superior results in all areas. Contributions towards the goals of the Authority are unique, beneficial and noticeably outstanding. A top achiever or administrator.

(Approximately 10 percent of the Executives would meet this standard.)

4.....ACCOMPLISHED - Performance is consistently above expectation. Achievemen on major assigned tasks and overall contribution are above expectation.

(Approximately 30 percent of the Executives would meet this standard.)

3.....COMPETENT - Performance reflecting a level of results which meets normal or average expectations. Overall contribution is of high quality.

(Approximately 45 percent of the Executives would meet this standard.)

2.....FAIR - Performance generally meets the standard normally expected but is inconsistent. Improvement is needed in one or more areas to consistently satisfy job requirements. An individual receiving an overall rating at this level will be involved in further action as outlined in PART II of this form.

(Approximately 10 percent of the Executives would fall within this standard.)

1.....UNSATISFACTORY - Performance is unacceptable. Individual has had ample opportunity to be knowledgeable about assigned tasks, but has not met the minimum expectations. An individual receiving an overall rating at this level will be involved in further action as outlined in PART II of this form.

(Approximately 5 percent of the Executives would fall within this standard.)

INSTRUCTIONS

Please use the scale on the following page to rate the individual's performance in each category. Read the criterion and select a numerical rating from 1 to 5 which most represents the employee's performance and supply specific comments, if appropriate. For detailed instructions, see Page 7 of this form.

		RATING
LEDGE OF GNED TASKS	Consider the degree of understanding of obligations pertinent to the position...the demonstration of proficiency as a result of knowing the job requirements.	____
ITY OF WORK	Consider the thoroughness, accuracy and effectiveness of work. How skillfully performed?	____
UCTIVITY	Consider demonstrated accomplishments and volume of work output. Does the person do what is expected and perhaps more?	____
MENT	Consider ability to plan work and make logical and practical decisions.	____
N RELATIONS	Consider the ability and willingness to develop good working relationships with associates, supervisors and others in the execution of assignments. Has the person abided by his or her responsibilities under the Authority's EEO/AA obligations?	____
ONSIBILITY	Consider the level of responsibility of the position. Does the person accept the responsibilities by concentrating on assigned tasks, utilizing time, planning the work and allocating resources?	____
NDABILITY	Consider the person's reliability with respect to attendance and work completion. Conscientiousness is most important.	____
ALL ORMANCE NG	Consider all of the above factors and select an overall performance rating.	____

PART II. FAIR OR UNSATISFACTORY PERFORMANCE

(Complete for any employee who receives an overall rating of fair or unsatisfactory and who needs to improve in one or more areas.)

Indicate next planned action:

________________ Further training

________________ Counseling

________________ Re-assignment

________________ Possible termination

________________ Other (please explain) ________________

____

____

PART III. ACCOMPLISHMENTS FOR THIS RATING PERIOD

Projects, assignments or plans agreed to in last appraisal	Target Date	Date Done	How well done? If not comple why not? Rescheduled for whe

V. OBJECTIVES FOR NEXT RATING PERIOD

Projects, Assignments or Plans	Priority	Target Dates

EMPLOYEE COMMENTS: (Optional)

SIGNATURES:

Rater ______________________ Date __________

Reviewed by ______________________

Employee ______________________

Department Head ______________________

Noted by Personnel ______________________

Noted by General Manager ______________________

SUPERVISORY COMMENTS: (Optional)

INSTRUCTIONS

is form shall be processed as follows:

A. Refer to the appraisal completed during the last review of the employee involved. Copies of appraisals shall be maintained by supervisors under confidential conditions. Assistance in obtaining previous appraisals that cannot be located is available from Personnel.

B. Review the employee's job description and determine from the last appraisal the standards of performance expected and the results that were achieved.

C. On the front of the form, fill in the identifying data pertaining to the person being rated.

D. Turn to Page 2 and review the criterion for each rating on the scale.

E. Proceed to appraise the employee on each of the Performance Factors set forth in PART I by placing a numerical rating after each factor in the space provided. Specific comments should be provided where necessary to clarify the performance factor rating. These comments should be related to work standards set from the job description and the goals and objectives set forth in PART III.

F. In the next section, select a rating which is your assessment of the employee' performance over the rating period and the contributions made by the employee to the department and organization.

G. If based on the prior section the employee receives a "Fair" or "Unsatisfactory rating, PART II must be completed.

H. In PART III, the objectives decided upon at the last appraisal shall be listed and assessed as to the degree of success in bringing them to a final conclusion.

I. PART IV will not be filled out until after the appraisal interview, since the employee will have input at that time. However, tentative goals for this employee, as you envision them, should be set forth in the Annual Performance Planning Worksheet, which should be attached. Then, sign the form in the space for the Rater on Page 6 of the PER-3(E).

J. Next, complete an Executive Employee Salary Review Report, PER-3(SRR), following the directions contained thereon. It then will be attached to the PER-3(E) Performance Appraisal and sent together through channels to the department head.

K. Both forms will be reviewed at the department head level for compliance with organizational objectives and for consistency with budgetary responsibilities. The forms then will be separated, and the PER-3(E) returned to the Rater, while the PER-3(SRR) shall be held at the department head level.

INSTRUCTIONS (Cont'd.)

L. Upon return of the PER-3(E) from the department head, the person rated shall be notified in writing, at least one day in advance, of the time and place of the interview. Also, accompanying the notification should be a copy of the employee's job description and a blank copy of an Annual Performance Planning Worksheet. The employee should be instructed to complete this form relative to his or her goals for the upcoming appraisal year and be prepared to discuss them at the performance interview, since this document will be the basis for the mutual establishment of the goals which will become criteria for measurement in PART IV of the PER-3(E) for the next year.

M. Conduct the appraisal interview, which is perhaps the most important segme of the appraisal process. Specific guidelines for such interviews are set forth in Staff Procedure No. 13A. The supervisor and the employee should mutually establish the goals and objectives for the next appraisal year by comparing the goals listed on the Annual Performance Planning Worksheets before reviewing the employee's performance for the current appraisal year

N. After completion of the interview, the employee should sign the form, indicating his/her awareness of the content. If a dispute exists relative to any portion of the evaluation, the employee should be afforded the opportunity to comment in the section provided on Page 6.

O. The PER-3(E) shall be forwarded through channels to the General Manager's level, with the PER-3(SRR) being attached at the appropriate level in the process.

P. Upon the General Manager's notation on the forms, the PER-3(E) shall be sent to the Personnel Department for inclusion in the employee's personnel file. Form PER-3(SRR) shall be forwarded to the Personnel Department for notation, and then to the Treasurer-Controller's Department for implementation of the salary adjustment.

(Space for further comments, if necessary):

Objectives must be achievable, realistic, measurable and time-bounded.

PRIORITY	OBJECTIVES (What must be accomplished?)	MEASUREMENT (Quantity, quality, cost or other)	TIME FRAME (Target date for completion)	PLAN FOR ACHIEVING THE OBJECTIVE (What must be done to accomplish objective?)

Signature ____________________ Date ____________

EXECUTIVE EMPLOYEE SALARY REVIEW REPORT

Name of Person Rated ______________________________

Department ______________________________

Position Title ______________________________

Grade ____________________ Present Salary ____________________

DIRECTIONS: The purpose of this report is to provide suggested guidelines for a sala
adjustment based on performance appraisal. It takes into account budget
constraints and requires comparison of job performance of the person rat
to other employees in the same department. Therefore, before you comple
this form for any one individual, you should make an overall assessment
and comparison of all the individuals you rate, if you evaluate more tha
one person. Refer to the PER-3(E), which will be attached to this form,
and, in particular, to the OVERALL PERFORMANCE RATING on Page 3, and the
suggested range of increases for 1983 ratings, set forth below. Write i
the spaces provided the individual's 1983 Overall Performance Rating, th
Recommended Percentage Increase and the Dollar Amount.

OVERALL PERFORMANCE RATING	SUGGESTED RANGE OF PERCENTAGE INCREASE
DISTINGUISHED	9 to 11
ACCOMPLISHED	7 to 9
COMPETENT	5 to 7
FAIR	1 to 4
UNSATISFACTORY	0

1983 OVERALL PERFORMANCE RATING ____________________ RECOMMENDED PERCENTAGE INCREASE __________ DOLLAR AMOUNT __________

SIGNATURES:

Rater ______________________________ Date __________

Reviewed by ______________________________

Department Head ______________________________

Noted by Personnel ______________________________

Noted by General Manager ______________________________

APPENDIX E

Estimate of Ridership Losses

APPENDIX E - ESTIMATES OF RIDERSHIP LOSSES

Summary

An analysis of November 1980 and 1981 ridership levels on the MBTA has revealed that a reduction in linked trips of 15.0 percent has occurred from 1980 to 1981. This represents approximately 90,200 fewer trips per average weekday. Of these trips, CTPS estimates that 32,000 trips were lost due to service cuts. Further, the MBTA estimates that 1,500 trips were lost due to the bus replacement program on the Mattapan High Speed Trolley Line. These two adjustments bring the loss in trips on the MBTA due solely to the fare increase of August 1981 to 56,700 trips per average weekday or a 9.4 percent reduction in total ridership.

This analysis used an average fare of 69.7 cents per trip in November 1981, which was derived from the results of a ridership sample taken during November. The November 1980 average fare was estimated at 43.5 cents.

Introduction

This memorandum describes the results of an analysis to determine ridership levels on the MBTA's rapid transit and bus lines during November 1981. This ridership level is compared with the level estimated for November 1980 to determine the magnitude of the loss in ridership due to the fare increase implemented in August and the service reduction made during the first six months of 1981.

The analysis was conducted by the Central Transportation Planning Staff (CTPS) at the request of the Massachusetts Bay Transportation Authority (MBTA) as part of the work being done for the preparation of the Environmental Impact Report (EIR) and Socioeconomic Impact Report (SEIR) on the MBTA Fare Increase. As part of the agreement which permitted the MBTA to increase fares prior to the completion of an EIR, the MBTA must determine the change in ridership for November 1981. CTPS's work was conducted to estimate the magnitude of the loss in ridership during November.

The basic sources of data and the methods used to estimate ridership on rapid transit and bus lines during November 1981 are briefly described in the next section. The results are then presented and are compared with ridership levels for November 1980. A detailed discussion of the assumptions and process is in the technical appendix.

Method of Analysis

The MBTA does not count total riders on a daily or monthly basis. Ridership levels, therefore, must be estimated using revenue (which is counted daily by the MBTA) and an estimate of the average fare paid by each rider. The average fare is based upon several factors: the mode used (rapid transit, local bus, zoned bus or express bus); the type of rider (full cash fare adult, elderly or handicapped, student or child); the method of fare payment (whether cash or prepaid pass); and the time of travel for elderly or handicapped riders. Since the ridership levels are dependent upon the average fare, and the average fare is dependent upon several variable factors, a program was instituted to determine the average fare being paid on the MBTA.

The MBTA, in conjunction with CTPS, developed a program to collect information on the components of average fare for bus, surface streetcar, and rapid transit lines. Due to time and money constraints, a sampling technique was used. CTPS selected a random sample of bus and Green Line driver runs and a sample of rapid transit stations. The samples were significant at the 0.05 level with a ± 2.5 percent confidence interval. The MBTA's staff of checkers collected the data during November. CTPS edited, coded, and analyzed the data.

For each bus or surface Green Line run sampled, the MBTA recorded the number of riders boarding and the type of fare paid--adult full cash or prepaid pass; elderly or handicapped (free or half fare); student (pass or half fare); or other free-authorized or unauthorized. The fare box revenue was also recorded, enabling the calculation of an average fare. The average fare was applied to total surface revenue to determine the number of riders on surface vehicles.

The number of rapid transit trips was derived using the MBTA's turnstile counts, an estimate of pass use, and the non-token revenue received at each station. The cash gate revenue was translated into riders by using an average fare derived from the sampling program. The sampling program provided information on the number of persons passing through the collector's booth turnstile or through the non-turnstile gates at rapid transit stations; the type of fare paid (full cash, prepaid pass or reduced fare); and the fare box revenue. Prepaid pass use was estimated from the turnstile passmeter readings and the sampling program.

These methods and the results of the analysis are explained more fully in the technical appendix to this memo.

November Ridership Levels

The number of unlinked surface and rapid transit trips in November 1981 are provided in Table 1. The ridership profiles, average fares and uses/pass for unlinked trips are also provided. An unlinked surface trip is defined as a trip made using only one surface vehicle. An unlinked rapid transit trip is defined as a trip made on the rapid transit system, including the underground portion of the Green Line and can include transfers from one transit line to another. These figures are compared with the number of unlinked trips for November 1980 as follows:

	Nov.'81	Nov.'80	% Change
Unlinked rapid transit trips/average weekday	310,100*	360,300	-13.9%
Unlinked surface trips/ average weekday	422,100	507,000	-16.7%
TOTAL	732,200	867,300	-15.6%

*Includes 4,400 previously uncounted DRTX trips.

The total loss in unlinked trips is approximately 16 percent.

An estimate of the number of linked trips was made using the ratio of rapid transit only, surface only, and transfer trips from the 1978 Wilbur Smith Systemwide Survey as a base and adjusting it for service cuts and fare increases instituted since then. The results are shown as follows:

Appendix E

TABLE E-1

DISTRIBUTION OF UNLINKED TRIPS BY FARE PAYMENT
(November 1981)

	Unlinked Rapid Transit Only	Unlinked Surface Only
Adult - cash	48.5%	39.6%
- prepaid pass	29.2%	30.7%
E & H - half fare	3.8%	5.3%
- free	11.1%	6.3%
Students	5.8%	12.2%
Other free - authorized*	1.2%	5.4%
- unauthorized	0.4%	0.5%
Total trips/average weekday	310,100	422,100
Uses/prepaid pass/month	44**	57**
Average fare	60.0 cents	39.6 cents

Source: Survey of November 1981 Ridership.

*Includes free trips in outbound direction surface Green Line.

**The uses per prepaid pass per month is not measured directly but rather has been derived from information on daily pass usage gathered from a sample of bus routes and rapid transit stations. Due to the estimation procedure, the values presented have a lower level of reliability than the other numbers presented, and care should be taken if used outside the context of this analysis.

Mode	Number of Trips/ Average Weekday (Nov. 1981)	Proportion	Average Fare
Rapid transit only	137,997	27%	60.0 cents
Combined rapid transit and surface trips	194,218	38%	98.9 cents
Surface only	178,885	35%	45.5 cents
TOTAL system	511,100	100%	69.7 cents

An estimate of the number of linked trips/average weekday in November 1980 shows that a loss of approximately 90,200 trips or 15.0 percent of the trips occurred, as follows:

Mode	Number of Trips/ Average Weekday (Nov. 1980)	Percent Change (1980-1981)
Rapid transit only	156,300	-11.7%
Combined rapid transit and surface trips	234,500	-17.2%
Surface only	210,500	-15.0%
TOTAL system	601,300	-15.0%

The ridership profiles are shown in Table 2. The greatest loss in trips was seen in the number of adults paying full cash fares. The largest increases were in the number of elderly riders and in the number of prepaid pass users. The distribution of riders by type of mode are presented in the appendix*; however, these distributions are made with less certainty and, therefore, care should be taken when using figures concerning the subcategories of users.

---

* Source: C.T.P.S. Tech. Report #39

Appendix E

TABLE E-2

DISTRIBUTION OF RIDERS BY FARE MIX
AVERAGE WEEKDAY (IN 000's)

	November 1981 # of Riders (%)	November 1980 # of Riders (%)	% Change
Adult - cash	209.6 (41.0%)	321.1 (53.4%)	-34.7%
- prepaid pass	174.8 (34.2%)	151.5 (25.2%)	+15.4%
E & H - half fare	22.0 (4.3%)	46.3 (7.7%)	+35.8%
- free	40.8 (8.0%)		
Students	45.0 (8.8%)	59.5 (9.9%)	-24.4%
Other free - authorized	16.9 (3.3%)	22.9 (3.8%)	-17.4%
- unauthorized	2.0 (0.4%)		
TOTAL	511.1 (100%)	601.3(100.0%)	-15.0%
Average fare	69.7 cents/trip	43.5 cents/trip	

Source: C.T.P.S.

In an attempt to determine the cause of the reduction in ridership, two major changes on the MBTA are cited: 1) the fare increase implemented in August 1981, and 2) the service reductions initiated in April 1981. In addition, it has been estimated that the bus replacement program on the Mattapan High Speed Trolley Line has caused a drop in ridership. Of the 90,200 fewer trips made on an average weekday than in 1980, CTPS estimates that 32,000 were lost due to service cuts (5.3 percent). The MBTA estimates that 4,500 (0.2 percent) of the lost trips were due to the bus replacement program. This, therefore, implies that the loss due to the fare increase was approximately 56,700 trips per average weekday (9.4 percent loss from November 1980).

Ridership figures have been adjusted since the publication of the Draft Environmental Impact Report, published in April 1982, to reflect better estimates of the ridership loss due to the DRTX Project. The following memo (Part II) shows the revised estimate of ridership loss due to the DRTX project. The revised estimate is 1,500 trips lost (down from 5000). Nine hundred additional trips were not counted for a total of 4,400 one-way trips.

To: Files

MASSACHUS
BAY
TRANSPORT
AUTHORITY

From: Alan H. Castaline

Date: June 9, 1982

Re: Ridership Loss Attributed to the DRTX Project
(Revised 7/1/82)

The DRTX Project was a track and tunnel reconstruction program fo the Mattapan High Speed Line and the Dorchester Branch of the Re Line. During the approximate seven month duration of the DRTX P gram, from June 1981 to January 1982, a bus replacement service provided. The replacement service was designed to carry about 7 80 percent of the Dorchester RTL commuters. The March 9, 1982 D Report prepared by CTPS entitled "MBTA Fare Study - Estimate of November Ridership" uses a previous crude estimate of 5,000 trip lost due to the DRTX Project.

The following presents an analysis to refine the previous estima for the number of trips lost due to the DRTX Project. For the p poses of this analysis, the DRTX ridership loss is divided into categories: (1) Passenger trips not counted by the November 198 Fare Survey, and (2) Passenger trips not made.

I. Passenger Trips Not Counted - Given the approach selected fo November Fare Survey and the methods used for estimating ridersh local travel between Dorchester Branch RTL Stations (between Ash and Andrew) were not recorded. Local trips were not observed by survey because these passengers neither entered through a RTL tu stile or contributed revenue to the surface receipts.

As shown in Table 1, historically there have been about 2,200 lo round trips made daily between Dorchester stations on the Red Li However, it is acknowledged that the approach used to derive thi timate does not account for a number of factors including:

o Ridership growth since 1978.

o Loss in ridership due to service cuts, the 1980 RTL fare incre and the 1981 bus fare increase.

o The influence of linking with RTL feeder bus service.

o New local ridership due to high frequency of service offered b replacement bus along Dorchester Avenue.

In total, the above is assumed to have no impact on the ridershi estimate for local travel, and therefore, it is estimated that 2 RTL round trips were not recorded by the November 1981 Survey.

Memo to Files
from Alan H. Castaline

Re: Ridership Loss Attributed to the DRTX Project

II. Passenger Trips Not Made - The CTPS draft report of March 9, 1982 assumed that 5,000 one-way trips were lost due to the DRTX Project. Table 2 presents a comparison of the boardings on the Dorchester Branch before (November 1980) and during (November 1981) the DRTX Project. It is now conservatively estimated that 750 daily round trips were not mad due to the inconvenience experienced by the Dorchester Red Line passengers. This is in addition to the estimated 2,200 round trips not observed by the November 1981 Survey.

III. Summary - Two adjustments to the conclusions presented by the CTPS memo of March 9, 1982, "MBTA Fare Study - Estimate of November Ridership," are required as shown in the following table:

	Existing Estimate		Revised	
Total Ridership Loss	94,600	(15.7%)	90,200	(15.0%)
Service	32,000	(5.3%)	32,000	(5.3%)
DRTX	5,000	(0.8%)	1,500	(0.2%)
Fare	57,600	(9.6%)	56,700	(9.4%)
Total 1981 Ridership	506,700		511,100	
Total 1980 Ridership	601,300		601,300	

The revised estimates reflect revisions associated with the refinement to the DRTX ridership and do not necessarily preclude the need for other adjustments in the calculations for the estimated daily ridership volumes for either 1980 and 1981.

Alan H Castaline

Alan H. Castaline
Acting Chief Service Planning Officer

AHC/wmh
Attachment

Table 1

DRTX Ridership Analysis

"Passenger Trips Not Counted"

	Boardings Inbound	Outbound*	Total
Andrew	3,476	806	4,282
Columbia	3,215	856	4,071
Savin Hill	1,365	249	1,614
Fields Corner	4,011	434	4,445
Shawmut	1,110	26	1,136
Ashmont	9,359	0	9,359
	22,536	2,371	24,907
Inbound Alighting*	2,608**	2,608	
Downtown Travel	19,928		
Local trips (one way)		4,979	
Est. South Shore O/D's		590	
Est. DRTX Local trips		4,389	

*Outbound Boardings and Inbound Alightings represent local travel. It is assumed that 33 percent of the loca trips through Andrew Station originate or are destined f the South Shore. Given the methods of sampling and estimating ridership used, the local DRTX trips were not reflected in the November 81 Fare Survey.

**See Table 1-A

Source: Tabulation of Station Boardings and Alightings from 1978 RTL Comprehensive Survey performed by Wilbur Smith and Associates and prepared by CT for the MBTA.

Table 1-A

DRTX Ridership Analysis

"Passenger Trips Not Counted"

Alightings

	Inbound	Outbound	Total
Andrew	964	3,661	4,625
Columbia	837	3,394	4,231
Savin Hill	272	1,426	1,698
Fields Corner	470	4,144	4,614
Shawmut	65	1,204	1,269
Ashmont	0	9,614	9,614
Totals	2,608	22,443	26,051

Source: Same as Table 1

Table 2

DRTX Ridership Analysis

"Passenger Trips Not Made"

	Nov 1980*	Nov 1981*
Ashmont	10,220	
Shawmut	1,687	
Fields Corner	5,244	
Savin Hill	1,942	
Columbia	4,538	2,667
Andrew	4,312	13,449
Subtotal	27,943	16,116
No. Quincy	4,754	9,181
Total	32,697	25,297
Local Trips		4,389
		29,686

November 1980	32,697	
November 1981	29,686	
Total Loss "DRTX" (unadjusted)	3,011	
	600	Less B.A.T. Passengers to Braintre
	2,411	
	1,260	Less loss due to Fare Inc
	1,151	
	384	Less estimated transfer t other services (assumed 3
Total Loss "DRTX"	767	Passenger round trips not made due to DRTX Project.

*Source: MBTA RTL 210 reports and "MBTA Fare Study" by CTPS, 3/9/82.

**Source: Brockton Area Transit

***Assumed fare elasticity of .15, with a weighted aver fare increase experienced by the DRTX riders on Augu 1982, of approximately 30 percent.

APPENDIX F

Appendix F-1 Air Quality Standards and Attainment p.405
Appendix F-2 Estimation Procedure of Transit Diversions to Other Modes p.415
Appendix F-3 Queuing Analysis p.423
Appendix F-4 The Energy Consequences of Traffic Congestion p.431
Appendix F-5 The Marginal Energy Consequences of Changes in Revenue Milage p.433
Appendix F-6 Emission Factors for Hydrocarbon Compounds, Carbon Monoxide, and Oxides of Nitrogen p.435
Appendix F-7 Calculation of Lead Emissions p.437
Appendix F-8 CO Hot Spot Analysis- Parameters p.441
Appendix F-9 Estimation of VMT Growth p.443
Appendix F-10 Annual and Monthly Vehicle Counts p.447
Appendix F-11 Memo on Energy Efficiency Changes p.455

Appendix F-1

Air Quality Standards and Current Attainment Levels

1. Ozone

The primary standard (to protect health) is 0.12 ppm for a one-hour period.

To be in attainment, the average number of days per year greater than this value must be less than or equal to 1 when averaged over 3 years.

The secondary standard (to protect vegetation & materials) = 0.12 ppm.

2. Carbon Monoxide

The primary standard = 9 ppm averaged over an 8-hour period
= 35 ppm averaged over a 1-hour period

To be in attainment, these levels are not to be exceeded more than once/year.

The secondary standard = same as primary.

MUNICIPALITY	# of OBS.	1980 MAX	2nd MAX	# of OBS.	1980 MAX	2nd MAX
BOSTON	682	.070	.068	7711	.115	107
BOSTON	4565*	.120	.110			
MEDFORD	1385**	.079	.073			
SOMERVILLE	3074	.140	.132			
WATERTOWN	3315	.145	.134			

NOTES: *When total observations are less than 2,000, the sample cannot be guaranteed to contain the actual maximum concentration value for the ozone season. An observation is a single hourly reading at a site; 100% data capture during the 4/1 to 10/31 ozone season represents 5,136 observations at each monitor.

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*Monitor in operation 7/1 to 7/31

**Monitor in operation 4/1 to 5/31

SOURCE: DEQE

AMBIENT OZONE DATA SUMMARY (1980-1981)

TABLE F

MUNICIPALITY	# of OBS	1980 MAX 1 HR (mg/M^3)	2nd MAX 1 HR	MAX 8 HR	2nd MAX 8 HR	# of OBS	1980 MAX 1 HR (mg/M^3	2nd MAX 1 HR	MAX 8 HR	2nd MAX 8 HR
BOSTON	5594	16	14	12	11	6571	22	16	14	10
BOSTON	2878*[a]	18	16	12	12					
BOSTON	1834*[b]	9	8	5	5	7344	12	12	10	8
BOSTON	2200*[c]	29	22	14	11	6512	22	22	14	12
MEDFORD	3497*[d]	20	19	12	12					
SOMERVILLE						7207	17	15	10	8
WATERTOWN	6167	10	10	8	7					

NOTE: *When total observations are less than 4,000, the sample cannot be guaranteed to include the actual maximum concentration value for the year. An observation is a single hourly reading at a site.

Carbon monoxide data are collected throughout the year; 100% data capture during that period represents 8,760 hourly observations.

---

a. Monitor in operation 1/1 to 6/30
b. Monitor in operation 7/1 to 12/31
c. Monitor in operation 10/1 to 12/31
d. Monitor in operation 1/1 to 6/30

SOURCE: DEQE

AMBIENT CARBON MONOXIDE DATA SUMMARY (1980-1981)

TABLE F-2

UNITS: UG/M^3

MUNICIPALITY	ARITH. MEAN	# of OBS.	1980 MAX. 1 HR.	ARITH. MEAN	# of OBS	1981 MAX. 1 HR.	ARIT MEAN
BOSTON	50	5186	338	93	6543	200	40
BOSTON	57	2333*[a]	395	101			
BOSTON		2029*[b]	197	61	7323	114	30
SOMERVILLE		346*[c]	132	45	5449	126	30
WATERTOWN		2182*[d]	417	37			

NOTE: *When total observations are less than 4,000, sample size is insufficient to represent sound data results. An observatio is the number of hourly readings taken at a site.

NMOC and NOx emission densities - MAPC Region, 1980. (in kg/hr/km^2)

NMOC	NOx
4.415	4.761

---

[a] Monitor in operation 1/1 to 4/30.
[b] Monitor in operation 7/1 to 12/31.
[c] Monitor in operation 10/1 to 12/31.
[d] Monitor in operation 6/1 to 9/30.

SOURCE: DEQE

AMBIENT NITROGEN DIOXIDE DATA SUMMARY (1980-1981)

TABLE F-

	Point Source	Area Source	Mobile Source	Total
NMOC (kg/day)				
- 1980	56,553	127,549	157,080	341,182
- 1987*	29,879	117,596	62,396	214,392
	-47%	-8%	-60%	-37%
NOx (kg/day)				
- 1980	123,981	86,079	202,285	412,255
- 1987*	114,171	93,420	168,635	376,226
	-8%	+9%	-17%	-9%

- Mobile source inventory: based on seasonally adjusted DVMT, and on emission factors (from Mobile-2)

- Bulk of projected highway vehicle emission reductions: due to FMVECP and the Mass. I&M Program which goes into effect on April 1, 1983.

	Point Source	Area Source	Mobile Source	Total
CO (kg/day)				
- 1980	15,598	40,494	1,643,433	1,699,525
- 1987	15,228	40,415	844,377	940,021
	-2%	-0.2%	-46%	-45%

- For mobile sources, emissions of CO were calculated in the same way as for NMOC & NOx. However, CO assumes winter conditions.

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*Shows impacts of existing DEQE Regulations, FMVECP and the Mass. I&M Plan.

Current and Attainment Levels
For Selected Indicator Pollutants
(Metropolitan Boston Region)

Table F-4

Through I&M implementations, the following reductions are anticipated for the Metropolitan Boston region:
(in kg/day for all Mobile Sources)

1983

NMOC

No I&M : 113,200
With I&M: 110,000
= -2.8%

CO

No I&M : 1,490,000
With I&M: 1,426,000
= -4.3%

1984

NMOC

No I&M : 74,900
With I&M: 60,200
= -20%

CO

No I&M : 1,281,000
With I&M: 924,000
= -28%

MASS. I&M PROGRAM

TABLE F-

Non-methane HC (or NMOC) - 191.3 tons/yr. = 631.1 kg/day

Exhaust CO - 2,929.2 tons/yr. = 9,633.0 kg/day

Exhaust NOx - 242.6 tons/yr. = 800.3 kg/day

Lead - 4.7 tons/yr. = 15.5 kg/day

REGIONAL EMISSION INCREASES DUE TO FARE INCREASES
IN KILOGRAMS PER DAY FOR COMPARISON

TABLE F-6

APPENDIX F - 2 : Estimation Procedure of Transit Diversions to Other Modes.

F-2 DIVERSION ANALYSIS*

The effects of the August 1981 fare increase, together with the ridership changes due to the 1980 fare increase, are expected to be a net decrease in daily passenger trips of approximately 85,000. This figure represents 42,500 round trips, of which roughly 24,000 (57%) are peak trips and 18,500 (43%) are off-peak.

Under the assumption that trips from the same area would exhibit similar behavior, the diverted trips have been disaggregated based on their assumed origins. The trips were divided into those made within the downtown, those made within the core, excluding the downtown, and those core-bound trips originating outside the core. The core area is defined as East Boston, Charlestown, Chelsea, Everett, Somerville, Cambridge, Brighton, part of Brookline, Roxbury, North Dorchester, and South Boston. The distribution of trips in each category is taken from the 1977 Program for Mass Transit (PMT).

Diverted trips were allocated to the core and corridors based on the percent of total existing transit trips that originate in each area. The only exception was that the diverted trips were skewed somewhat toward the downtown-to-downtown and core-to-core trips to reflect the assumption that a higher percentage of short trips than long trips will be lost. (See Table F-7.)

Within each geographic category, the diverted transit trips then had to be assigned to alternate modes or trip-making behaviors. The alternatives included: taxi, automobile, commuter rail, private bus, walk/bike, other destination, and no trip. The percent of the travel in each category assigned to each mode is based largely on the relative accessibility of the alternative modes. Trip purposes, average trip lengths, automobile ownership, and other factors were also considered. (See Table F-8.)

Three modes needed to be considered in the calculation of new VMT. These are automobile, taxi, and "other destination". All trips assigned to the "other destination" category are assumed to be made by automobile. Combining the mode split for diversions with the number of diverted trips yields a breakdown of diverted passenger trips by automobile for each area. (See Table F-9.)

In order to convert these trips into VMT, trip lengths and vehicle occupancies must be diverted. Automobile occupancies were assumed to be 2.3 and 1.6 for peak and off-peak, respectively.

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*Discussion from CTPS memorandum prepared by Katrina Kalish, "Estimates of Diversions of Transit Users to Other Modes," February 15, 1982.

GEOGRAPHIC DISTRIBUTION OF LOST TRIPS

	Percent of Total	Percent of Lost Trips	Number of Lost Trips
North Shore	7.6	6.7	5700
North	11.4	10.1	8600
Northwest	10.4	9.0	7600
West	11.3	10.1	8600
Southwest	10.1	9.0	7600
South Shore	17.9	15.7	13300
Within Downtown	8.2	16.4	14000
Within Core	23.1	23.1	19600
	100%	100%	85000

Source: C.T.P.S. Memorandum, Estimate of Diversion of Transit Us to Other MOdes Due to the 1981 MBTA Fare Increase. Feb.1 1982.

GEOGRAPHIC DISTRIBUTION OF LOST TRIPS

TABLE F- 7

DIVERSIONS TO OTHER MODES FROM TRANSIT

(Rows total to 100.0)

	No Trip	Other Dest.	Walk/ Bike	Private Bus	Comm. Rail	Auto	Taxi
North Shore	10	15	5	10	15	45	-
North	10	15	5	5	15	50	-
Northwest	10	15	5	5	15	50	-
West	10	15	5	10	10	50	-
Southwest	10	20	5	5	20	40	-
South Shore	10	15	5	15	-	55	-
Within Downtown	20	5	35	-	-	15	25
Within Core	20	10	15	-	-	45	10

Source: C.T.P.S. Memo, Estimate of Diversion of Transit Users to Other Modes due to the 1981 MBTA Fare Increase, Feb.15, 1981.

DIVERSIONS TO OTHER MODES FROM TRANSIT

TABLE F-8

	Taxi	Auto	Other Destination
North Shore	--	2,560	850
North	--	4,290	1,280
Northwest	--	3,820	1,150
West	--	4,290	1,280
Southwest	--	3,060	1,530
South Shore	--	7,330	2,000
Within Downtown	3,500	2,090	700
Within Core	2,000	8,840	1,960

Source: C.T.P.S.

TABL
F.-

GEOGRAPHIC DISTRIBUTION OF PASSENGER TRIPS DIVERTED TO AUTOMOBILE

	VMT By Taxi	VMT By Auto	VMT to Other Destinations	TOTAL
North Shore		14,400	4,400	18,800
North		24,100	6,800	30,900
Northwest		21,600	6,000	27,600
West		24,100	6,800	30,900
Southwest		17,300	8,100	25,400
South Shore		41,300	10,500	51,800
Within Downtown	7,000	1,800	800	9,600
Within Core	9,800	19,200	6,100	35,100
				230,100

Source: C.T.P.S.

TABLE
F-10

GEOGRAPHIC DISTRIBUTION OF DIVERTED VMT/DAY

Downtown trips - 2 miles (based on average taxi trip length)

Core trips - 2 miles

Regional Home Based Work trips - 13.4 miles

Regional Non-work trips - 8.46 miles

The following calculations were used to remove the influence of downtown and core trips on the regional Home Based Work and Non-work trip lengths:

PMT Trip Distribution		
	CBD to CBD	2.2%
	Core to Core	16.9%
	Corridor to Core	80.9%

Corridor Home Based Work Trip Lengths

Regional components (trip length x percent of region)

$$(.022 \times 2) + (.169 \times 5) + (.809 \times L) = 13.4 \text{ miles}$$
$$.809L = 12.5 \text{ miles}$$
$$L = 15.5 \text{ miles}$$

Corridor Non-Work Trip Lengths

$$(.022 \times 2) + (.169 \times 5) + (.809 \times L) = 8.46 \text{ miles}$$
$$.809L = 7.6 \text{ miles}$$
$$L = 9.4 \text{ miles}$$

A SUMMARY OF TRIP LENGTH ASSUMPTIONS USED

TABLE F

This reflects the belief that most commuters who leave the transit system because of a fare increase will not drive alone. Trips by car to other destinations were assumed to have occupancy rates of 1.6, while taxis were assigned a single passenger each. EOTC has established a carpool occupancy rate of 2.5 persons (Analysis of Transportation of Massachusetts Third Party Vanpool Program, August 1980).

One-way trip lengths were based on area of origin, time of day (peak or off-peak), type of tripmaker (student or other), and destination (core or other). Trips within downtown were assumed to have an average trip length of two miles; the Transportation Element of the State Implementation Plan (TE/SIP) cited this as the average length of downtown taxi trips. "Within Core" trips were estimated to have an average length of five miles based on an average distance from the outer core areas to the downtown. Several trip lengths were used for trips from the corridors to the core. These were based on regional trip lengths cited in the TESIP, adjusted by using two- and five-mile averages for those trips within the region that occurred within the core and the downtown. For instance, the regional home-based work trip length was 13.4 miles; weighting this using two and five miles for downtown and core trips leaves a corridor-to-core trip length of 15.5 miles. Off-peak trips by automobile and both peak and off-peak trips to other destinations had estimated trip lengths of 9.4 miles. The figures were adjusted for students and children who were assumed to make shorter trips averaging three miles based on likely schoolbound trip lengths.

Based on the estimated number of diverted trips, the mode splits, the trip lengths, and the vehicle occupancies, the increases in daily VMT are predicted and displayed in Table SF-10 and F-11.

The net result is thus an additional 230,100 daily VMT or approximately 69.0 million VMT annually. This represents an increase of roughly 0.5 percent of regional daily VMT.

Sources: Trip Purposes: EOTC Staff Report #1, Transportation Needs-Transportation Services, Section IV "Demographic and Travel Characteristics."
Auto Ownership: EOTC Staff Report #1, Section II "Population Characterisitcs"
Trip Length: 1978 TE/Sip, Appendix E.

Sample VMT Calculation (North Corridor)

Lost Trips: 8,580

Trips Lost to Auto: 4,290

Trips Lost to Other Destinations: 1,280

Increased Auto VMT

Trips Lost to Autos	Child Trips (x .15)	Child Trip Miles (x 3.0)	Peak Adult Trips (x .48)	Peak Adult Miles (x 15.5)	Off-Peak Adult Trips (x .37)	Off-Peak Adult Miles (x 9.4)	Apply Occupancy Rate			Total Additional Auto VMT
							Child ÷ 2	Peak Adult ÷ 2.3	Off-Peak Adult ÷ 1.6	
4,290	643	1,930	2,059	31,917	1,587	14,920	965	13,876	9,325	24,166

Increased Other Destination VMT

Trips Lost to Other Destinations	Adult Trips (All Periods) (x .85)	Adult Trip Miles (x 9.4)	Child Trips (x .15)	Child Trip Miles (x 3.0)	Occupancy Rate 1.6		Total Additional Other Destination VMT
					Child	Adult	
1,280	1,088	10,227	192	576	360	6,391	6,751

Source: CTPS Project Files

F-3 QUEUING ANALYSIS

It has been assumed that the MBTA fare increase will cause automobile use to increase. Additional volumes of traffic on the radial highways into Boston would, in turn, cause queue lengths to increase.

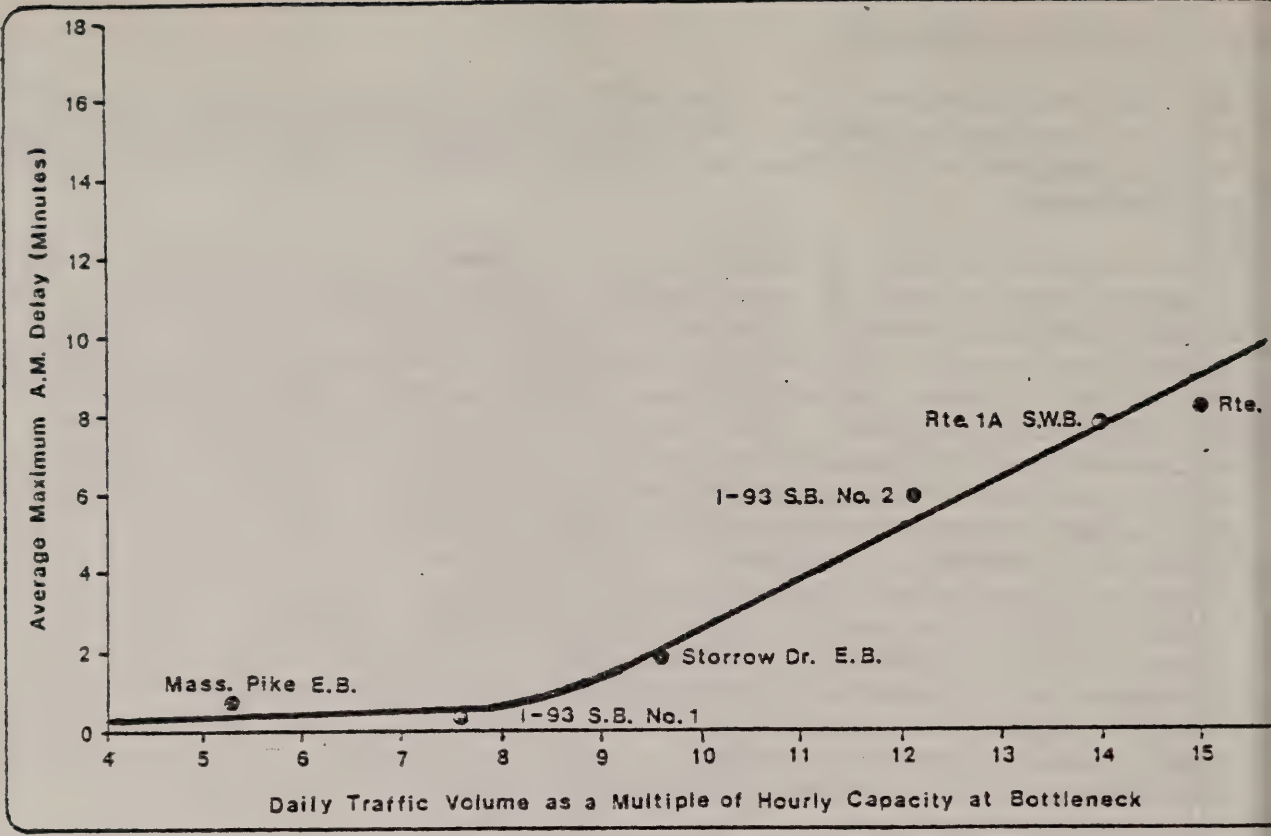
This section takes up the question of estimating increased queue lengths for AM and PM peak trips, respectively, to and from the Boston central area. Further, this section will examine the resulting energy and fuel consumption consequences of congestion. For this purpose, an expressway queuing model developed recently by CTPS will be used. The model predicts AM inbound and PM outbound queuing delays on express highway facilities based on daily traffic volumes relative to capacities at bottleneck points. The delay curves developed and used in the model for AM and PM peaks are shown in Figure F-1 and Figure F-2 As seen in the figures, bottleneck delays begin for both AM and PM peaks when daily traffic volumes at bottleneck points approach eight to ten times hourly capacity. During the morning peak period, delays increase at a rate of 1.25 minutes for every increase in daily traffic equal to hourly bottleneck capacity. During the evening peak, delays increase twice as quickly, increasing at a rate of 2.50 minutes for every increase in daily traffic equal to hourly bottleneck capacity.

In order to apply the curves of Figures F-1 and F-2 in estimating increased queue lengths, increased automobile trips have been estimated by corridor and assigned to facilities as shown in Table F-13. The actual delay calculations are shown in Table F-14 for the AM peak and in Table F-15 for the PM peak. It was estimated that the average maximum delay is measured based on the queue speed and length of time to traverse bottlenecks versus the normal free-flow speed required to traverse the same distance. (Figured on the basis of time/mile at zero volume speed.) As shown in the tables, average delays increase about one-quarter minute during the AM peak and about one-half minute during the PM peak. These delay increases apply to all vehicles on the radial routes, not just the new ones. Figure F-3 shows calculations for both delay-based and acceleration/deceleration-based modeling of total increase in gasoline use through queuing delays.

Queue length changes range from 35 feet to about one-half mile. The larger changes in queue lengths shown for Storrow Drive and the Southeast Expressway are not due to extraordinary traffic changes, but to the fact that these facilities do not have explicit queues. For example, the Southeast Expressway is not technically a queue but a stop-and-go level-of-service "F" roadway. Since these two roadways have base case speeds which are faster, it takes more distance to generate a given amount of delay increase.

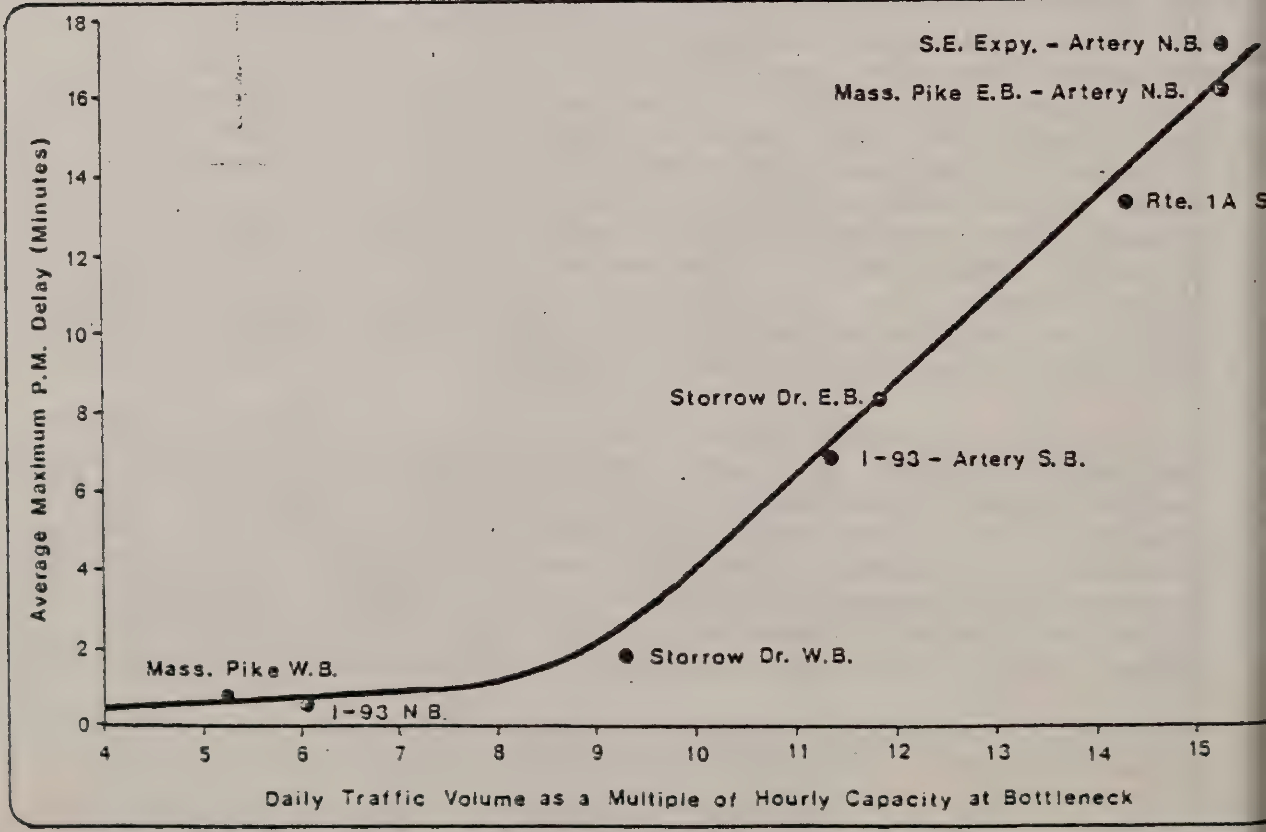
The actual procedure used in calculating delay and queue increases is as follows. (Refer to Tables F-14 and F-15)

Line 1: Hourly Bottleneck Capacity. Hourly capacity at bottleneck point; estimated to be 10 times the hourly capacity at a given service level.



DAILY TRAFFIC VOLUME AS A MULTIPLE OF HOURLY CAPACITY AT BOTTLENECK VS. AVERAGE MAXIMUM A.M. PEAK DELAY

Figu
F-



DAILY TRAFFIC VOLUME AS A MULTIPLE OF HOURLY CAPACITY AT BOTTLENECK VS. AVERAGE MAXIMUM P.M. PEAK DELAY

Figu
F-

(Delay-based)

.6 gallons/hour used idling

AM .0025 gallons used every 155 seconds
.0025 x 270,614 = 677 gallons/morning peak

PM .005 gallons every 30 seconds
.005 x 259,380 = 1,297 gallons/evening peak

1,974 gallons/day x 260 = 513,240 gallon/yr.
(workdays/year)

513,240 11% increase over 4.7 million gallons/year

(Acceleration/Deceleration-based)

30-10-30 cycle	.0035
45-14-45 cycle	.005

(average of zero volume speed - average queue speed - average zero volume speed)

AM .005 x 270,614 = 1,353
PM .005 x 259,380 = 1,297

2,650 gallons/day

2,650 gpd x 260 = 689,000 gallons/year
(workdays/year)

689,000 15% increase over 4.7 million gallons/year

ESTIMATION OF INCREASED GASOLINE CONSUMPTION THROUGH QUEUING DELAYS

FIGURE F-3

Origin	Number	Assigned Route
East Boston	100	Sumner Tunnel
Chelsea	120	Rte. 1, Tobin Bridge
Cambridge	380	Storrow Drive (Memorial Dr.)
Brighton	270	Storrow Drive (Memorial Dr.)
No. Dorchester	90	Southeast Expressway
North Shore	1,370	80% Rte. 1, 20% Sumner Tunnel
North	2,210	I-93
Northwest	1,970	50% I-93, 50% Storrow Drive
West	2,210	Mass Pike
Southwest	1,580	50% Mass Pike, 50% S.E. Expressway
South Shore	3,780	Southeast Expressway

I-93	2,210 + 985	= 3,195
Rte. 1	120 + 1,100	= 1,220
Sumner	100 + 270	= 370
S.E. Expressway	90 + 790 + 3,730	= 4,610 → 3,600
Mass Pike	2,210 + 790	= 3,000 → 3,160
Storrow Drive	380 + 270 + 985	= 1,635 → 1,070

Modifications due to congestion

S.E. Expressway: divert 1010 to arterials
Mass Pike: accept 160 from Storrow Drive
Storrow Drive: divert 10% (1,601) to Mass Pike and 25% (405) to Memorial Drive

ESTIMATED AND ASSIGNED ADDITIONAL INBOUND AUTOMOBILES RESULTING FROM MBTA FARE INCREASE

TABLE F-13

		Central Artery to I-93 & Rte. 1	Storrow Drive to I-93 & Rte. 1	Callahan Tunnel	Southeast Expressway	Mass Turnpike	Storrow Drive
1	Hourly Bottleneck Capacity[1]	2,800	2,200	3,100	8,000	8,400	3,400
2	Base Case AWDT	42,619	25,960	41,034	74,479	43,871	31,416
3	Base Case Daily Volume, Hourly Capacity	15.22	11.80	13.24	9.31	5.22	9.24
4	Base Avg. Max. Delay	∿17½ min.	∿8½ min.	in other queues	Varies	--	∿2 min.
5	Daily Traffic Increase	2,740[3]	1,675[3]	370	3,655	3,160	1,079
6	New AWDT	45,359	27,635	41,404	78,134	47,031	32,489
7	New DV ÷ HC	16.20	12.56	13.36	9.77	5.71	9.56
8	Change DV ÷ HC	0.98	0.78	0.12	0.46	0.38	0.31
9	Change in Average Max. Delay[2]	2.45	1.90	0.44	1.14	--[4]	0.74
10	1/2 Δ Avg. Max. Delay[5]	1.22	0.95	0.22	0.57	--	0.39
11	Zero Volume Speed	50	40	40	55	55	40
12	Time/Mile at Z.V.S.	1.200	1.500	1.500	1.091	1.091	1.500
13	Avg. Queue Speed	10	5	5	25	55	25
14	Queue Time Per Mile	6.000	12.000	12.000	2.400	1.091	2.400
15	Δ Time/Mile in Queues	4.800	10.500	10.500	1.309	--	.900
16	Δ Miles of Queue	0.254	0.905	0.021	.435	--	.433
17	Δ Feet of Queue	1.342	478	111	2.297	--	2.288
18	Base Case 4-Hour Traffic	11,525	8,080	10,495	26,584	16,250	10,375

[1] Defined as 10 times hourly capacity at bottleneck point.

[2] Based on 25.0 minutes added delay per 1.0 increase in V/C (Delay Model 3C).

[3] Based on 62%/33% split on Rte. 1 and I-93 assumed Traffic from Central Artery & Storrow Drive.

[4] Below threshold rate for delay increases.

[5] Assuming average delay is one-half average maximum delay.

EXPRESSWAY QUEUING IMPACTS OF 1981 MBTA FARE INCREASE -- AM PEAK PERIOD

TABLE F-14

		Central Artery to I-93 & Rte. 1	Storrow Drive to I-93 & Rte. 1	Callahan Tunnel	Southeast Expressway	Mass. Turnpike	Storrow Drive
1	Hourly Bottleneck Capacity[1]	2,800	2,200	3,100	8,000	8,400	3,400
2	Base Case AWDT	42,619	25,960	41,034	74,479	43,871	31,416
3	Base Case Daily Volume, Hourly Capacity	15.22	11.80	13.24	9.31	5.22	9.24
4	Base Avg. Max. Delay	~17½ min.	~8½ min.	in other queues	Varies	--	~2 min.
5	Daily Traffic Increase	2,740[3]	1,675[3]	370	3,655	3,160	1,079
6	New AWDT	45,359	27,635	41,404	78,134	47,031	32,489
7	New DV ÷ HC	16.20	12.56	13.36	9.77	5.71	9.56
8	Change DV ÷ HC	0.98	0.78	0.12	0.46	0.38	0.31
9	Change in Average Max. Delay[2]	2.45	1.90	0.44	1.14	--[4]	0.74
10	1/2 Δ Avg. Max. Delay[5]	1.22	0.95	0.22	0.57	--	0.39
11	Zero Volume Speed	50	40	40	55	55	40
12	Time/Mile at Z.V.S.	1.200	1.500	1.500	1.091	1.091	1.500
13	Avg. Queue Speed	10	5	5	25	55	25
14	Queue Time Per Mile	6.000	12.000	12.000	2.400	1.091	2.400
15	Δ Time/Mile in Queues	4.800	10.500	10.500	1.309	--	.900
16	Δ Miles of Queue	0.254	0.905	0.021	.435	--	.433
17	Δ Feet of Queue	1.342	478	111	2.297	--	2.288
18	Base Case 4-Hour Traffic	11,525	8,080	10,495	26,584	16,250	10,375

[1] Defined as 10 times hourly capacity at bottleneck point.

[2] Based on 25.0 minutes added delay per 1.0 increase in V/C (Delay Model 3G).

[3] Based on 62%/33% split on Rte. 1 and I-93 assumed Traffic from Central Artery & Storrow Drive.

[4] Below threshold rate for delay increases.

[5] Assuming average delay is one-half average maximum delay.

EXPRESSWAY QUEUING IMPACTS OF 1981 MBTA FARE INCREASE -- PM PEAK PERIOD

TABLE F-15

Key to Table 15

Line 2: Base Case AWDT. Actual daily volume at bottleneck point before fare increase.

Line 3: Base Case Daily Volume Divided by Hourly Capacity. Line 1 divided by Line 2.

Line 4: Base Case Average Maximum Delay. From Figure 1 and Figure 2, from values of daily volume divided by hourly bottleneck capacity.

Line 5: Daily Traffic Increase. From Table 5.

Line 6: New AWDT. Line 2 plus Line 5.

Line 7: New Daily Traffic Divided by Hourly Capacity. Line 6 divided by Line 1.

Line 8: Δ Daily Traffic Divided by Hourly Capacity. Line 7 minus Line 3.

Line 9: Δ Average Maximum Delay. Line 8 multiplied by 1.25 for AM peak; 2.50 for PM peak.

Line 10: One-Half Δ Average Maximum Delay. Line 9 divided by two. Assumes that the average vehicle during the peak period encounters one-half the average maximum delay.

Line 11: Zero Volume Speed. Speed of the relevant section of highway when conditions are uncongested. Source: CTPS Speed Runs.

Line 12: Time Per Mile at Zero Volume Speed. Time taken by a vehicle to traverse a mile of the relevant section of highway with uncongested conditions:

$$\left(\frac{1}{\text{Zero Volume Speed}} \times 60\right)$$

Line 13: Average Queue Speed. Typical speed on the relevant section of highway under conditions of queuing. Source: CTPS Speed Runs.

Line 14: Queue Time Per Mile. Time taken by a vehicle to traverse a mile of the relevant section of highway under queued conditions:

$$\left(\frac{1}{\text{Queue Speed}} \times 60\right)$$

Line 15: Δ Time Per Mile in Queue. Line 14 minus Line 12.

Line 16: Δ Miles of Queue. The number of miles of queue necessary to increase delay by the amount shown on Line 10. Line 10 divided by Line 15.

Line 17: Δ Feet of Queue. Line 16 times 5,280.

Line 18: Base Case Four-Hour Traffic. From MDPW traffic counts.

From Tables F-14 and F-15, the increased queue lengths of Line 16 and 17 may be applied to the peak period vehicles of Line 18 t calculate energy/air quality changes, using changes in vehicle speeds from those of Line 11 to those of Line 13.

F-4 THE ENERGY CONSEQUENCES OF TRAFFIC CONGESTION

Traffic congestion will increase the original yearly estimate of motor fuel consumption (caused by the fare increase) by 11% to 15%(see Figure F-3). Assuming each car undergoes an additional 15-second delay in the peak AM and a 30-second delay in the peak PM, gasoline consumption, based on a rate of .6 gallons/hour used idling,* would increase by 677 gallons each morning and 1,297 gallons each evening. Of course, the assumption here is that the respective delays are accounted for in vehicle idling. Based on a 260-day work year, another 513,240 gallons of fuel would be used (11%).

Deceleration and re-acceleration also uses extra fuel over and above constant cruising speed. A 30mph — 10mph — 30mph cycle results in increased gas consumption of .0035 gallons over steady cruising speed. The average drop in zero volume speed to queuing speed at bottleneck points averages over 30mph (45-14)** during morning and evening peaks. (Idling time is not figured in, but appears in the average queue speed.) Reattainment of cruising speed in these vehicles would probably consume more than .0035 gallons. Assigning a value of .005 extra gallons for a net 30mph acceleration/deceleration/acceleration cycle yields, over a work day, a figure of 689,000 (15%) additional gallons consumed. This is a "soft" figure and probably less accurate than the "delay-based" figure for two reasons:

(1) Some acceleration/deceleration cycle was present at bottleneck points before the delay, and

(2) It is impossible to determine at what point in time acceleration and deceleration occur. Some vehicles may decelerate at end of trip and never resume cruising speed.

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*Guidelines to Reduce Energy Consumption Through Transportation Actions, UMTA, May 1974, p. 4-51.

**Not including Mass Pike (no bottleneck).

F-5 THE MARGINAL ENERGY CONSEQUENCES OF CHANGES IN REVENUE MILEAGE

As was discussed in Section 2.8.1., a significant portion of systemwide energy use is unaffected by total vehicle mileage. The following calculation demonstrates the effect on the MBTA system energy efficiency associated with 10 percent increase in rail vehcicle revenue mileage:

1981 35,711,187 Rev. Miles (Rail & Bus) 3,914,565 x 10^6 BTU

1982 (10% Increase) 39,282,305 Rev. Miles (Rail & Bus) 921,679 x 10^6 BTU
48,643
Elec. 853,830 (Non-Traction)
2,299,454 (Traction)
TOTAL 4,123,606 x 10^6 BTU

1981 $\frac{35,711,187}{3,914,565}$ x 0.125701 = 1.1467 MPG

1982 (10% Increase Mileage) $\frac{39,282,305}{4,123,606}$ x 0.125701 = 1.19745 MPG

$\frac{1.1467-1.1975}{1.1467}$ x 100%: 4.4% Improvement in Energy Efficiency Systemwide with 10% Increase in Rail Vehicle Miles

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10% Increase Mileage = 3,571,119 Miles

Assume 4.29 Passengers/Mile = 15,320,100 Increased Passengers

This indicates that the marginal energy efficiency of increased mileage in the system is great and produces significant increases in systemwide efficiency as well.

F-6 EMISSION FACTORS FOR HYDROCARBON COMPOUNDS, CARBON MONOXIDE, AND OXIDES OF NITROGEN

With the exception of lead calculatons, the emission factors used throughout the air quality analysis are from MOBILE2, an EPA computer program that calculates emission factors in grams per mile for various pollutants, including HC, CO, and NO_x. Calculations referring to total hydrocarbons (HC) in the analysis were based on the reactive hydrocarbons (non-methane hydrocarbons or NMHC), the principal hydrocarbons found in auto emissions. The factors were supplied to CTPS by DEQE and were adjusted to reflect the Massachusetts vehicle fleet.

Factors were obtained for several speeds: 5, 10, 25, 27, 30, 39, 40, 50, and 55 mph. Five, 10, and 25 mph were used to reflect speeds for queues on selected highways; 40, 50, and 55 mph reflect free flow speeds on highways; 27, 30, and 39 mph reflect speeds used for within downtown, within core, and corridor-to-core trips, respectively, based on speeds associated with appropriate functional classifications.

The proportions of vehicles operating in cold start (20.6 percent), hot start (27.3 percent), or hot stabilized (52.1 percent) conditions were assumed to be the national average default values for the regional emissions analysis and the PM peak period queuing analysis. All automobiles were assumed to be operating in the hot stabilized mode for the AM peak period queuing analysis. Ambient temperatures that represent worst-case conditions were used: 75°F for HC and NO_x, and 20°F for CO.

Lead emissions were calculated in a different manner, as is presented in Appendix Section F- 7.

```
COMPOSITE EMISSION FACTORS (GM/MILE)
NO-MTH HC:  4.71   4.33   5.64   4.78  14.83     .67     .88    4.06    7.82    5.13
EXHST  CO: 48.86  43.34  47.68  44.84 224.41    1.50    2.02   12.51   28.71   54.01
EXHST NOX:  3.12   3.30   3.97   3.53  10.09    1.56    1.83   25.12     .52    4.15

HOT STABILIZED IDLE EMISSION FACTORS (GM/MIN)
NM-ID  HC:   .79    .62    .70    .65   1.02     .04     .10     .35    1.38     .77
 IDLE  CO: 14.02  10.71   9.07  10.15   9.90     .19     .34     .89    3.69   12.73
 IDLE NOX:   .19    .09    .07    .08    .06     .20     .32     .92     .02     .19
-------------------------------------------------------------------------------------

 CAL. YEAR: 1980       REGION: 49-STATE LOWALT.            ALT:  500. FT.
                            TAMB: 75.0(F)          30.0/ 27.3/ 30.0

VEH. TYPE:  LDGV  LDGT1  LDGT2   LDGT   HDGV    LDDV    LDDT    HDDV     MC   ALL VEH
VEH. SPD.: 24.0   24.0   24.0           24.0    24.0    24.0    24.0    24.0
  VMT MIX:   .778   .087   .046           .042    .005    .001    .033    .009

COMPOSITE EMISSION FACTORS (GM/MILE)
NO-MTH HC:  4.33   3.99   5.14   4.38  12.98     .61     .80    3.65    7.29    4.68
EXHST  CO: 43.28  38.60  41.95  39.76 194.02    1.30    1.75   10.86   25.61   47.64
EXHST NOX:  3.28   3.48   4.13   3.71  10.36    1.49    1.74   23.94     .55    4.27

HOT STABILIZED IDLE EMISSION FACTORS (GM/MIN)
NM-ID  HC:   .79    .62    .70    .65   1.02     .04     .10     .35    1.38     .77
 IDLE  CO: 14.02  10.71   9.07  10.15   9.90     .19     .34     .89    3.69   12.73
 IDLE NOX:   .19    .09    .07    .08    .06     .20     .32     .92     .02     .19
-------------------------------------------------------------------------------------

 CAL. YEAR: 1980       REGION: 49-STATE LOWALT.            ALT:  500. FT.
                            TAMB: 75.0(F)          30.0/ 27.3/ 30.0

VEH. TYPE:  LDGV  LDGT1  LDGT2   LDGT   HDGV    LDDV    LDDT    HDDV     MC   ALL VEH
VEH. SPD.: 27.0   27.0   27.0           27.0    27.0    27.0    27.0    27.0
  VMT MIX:   .778   .087   .046           .042    .005    .001    .033    .009

COMPOSITE EMISSION FACTORS (GM/MILE)
NO-MTH HC:  4.00   3.69   4.71   4.04  11.55     .55     .72    3.31    6.86    4.31
EXHST  CO: 38.45  34.36  37.09  35.30 171.10    1.15    1.55    9.59   23.12   42.27
EXHST NOX:  3.42   3.66   4.28   3.87  10.62    1.44    1.68   23.11     .58    4.39

HOT STABILIZED IDLE EMISSION FACTORS (GM/MIN)
NM-ID  HC:   .79    .62    .70    .65   1.02     .04     .10     .35    1.38     .77
 IDLE  CO: 14.02  10.71   9.07  10.15   9.90     .19     .34     .89    3.69   12.73
 IDLE NOX:   .19    .09    .07    .08    .06     .20     .32     .92     .02     .19
-------------------------------------------------------------------------------------

 CAL. YEAR: 1980       REGION: 49-STATE LOWALT.            ALT:  500. FT.
                            TAMB: 75.0(F)          30.0/ 27.3/ 30.0

VEH. TYPE:  LDGV  LDGT1  LDGT2   LDGT   HDGV    LDDV    LDDT    HDDV     MC   ALL VEH
VEH. SPD.: 30.0   30.0   30.0           30.0    30.0    30.0    30.0    30.0
  VMT MIX:   .778   .087   .046           .042    .005    .001    .033    .009

COMPOSITE EMISSION FACTORS (GM/MILE)
NO-MTH HC:  3.72   3.42   4.35   3.74  10.44     .50     .66    3.03    6.48    3.99
EXHST  CO: 34.26  30.61  32.92  31.41 153.91    1.03    1.39    8.60   21.02   37.72
```

```
VEH. SPD.: 55.0   55.0   55.0           55.0    55.0    55.0    55.0    55.0
  VMT MIX:   .778   .087   .046           .042    .005    .001    .033    .009

COMPOSITE EMISSION FACTORS (GM/MILE)
NO-MTH HC:  2.78   2.57   3.09   2.75   7.11     .34     .45    1.95    5.21    2.94
EXHST  CO: 22.01  20.15  20.32  20.21 137.53     .79    1.05    6.59   14.02   25.89
EXHST NOX:  4.03   4.41   4.94   4.59  13.08    1.91    2.24   30.76     .70    5.32

HOT STABILIZED IDLE EMISSION FACTORS (GM/MIN)
NM-ID  HC:   .79    .62    .70    .65   1.02     .04     .10     .35    1.38     .77
 IDLE  CO: 14.02  10.71   9.07  10.15   9.90     .19     .34     .89    3.69   12.73
 IDLE NOX:   .19    .09    .07    .08    .06     .20     .32     .92     .02     .19
-------------------------------------------------------------------------------------

 CAL. YEAR: 1980       REGION: 49-STATE LOWALT.            ALT:  500. FT.
                            TAMB: 75.0(F)          30.0/ 27.3/ 30.0

VEH. TYPE:  LDGV  LDGT1  LDGT2   LDGT   HDGV    LDDV    LDDT    HDDV     MC   ALL VEH
VEH. SPD.: 15.0   15.0   15.0           15.0    15.0    15.0    15.0    15.0
  VMT MIX:   .778   .087   .046           .042    .005    .001    .033    .009

COMPOSITE EMISSION FACTORS (GM/MILE)
NO-MTH HC:  5.82   5.30   7.11   5.93  20.42     .85    1.12    5.14    9.48    6.43
EXHST  CO: 65.02  56.31  64.75  59.23 318.58    2.09    2.81   17.42   38.89   72.66
EXHST NOX:  2.82   2.93   3.63   3.17   9.56    1.79    2.09   28.74     .47    3.97

HOT STABILIZED IDLE EMISSION FACTORS (GM/MIN)
NM-ID  HC:   .79    .62    .70    .65   1.02     .04     .10     .35    1.38     .77
 IDLE  CO: 14.02  10.71   9.07  10.15   9.90     .19     .34     .89    3.69   12.73
 IDLE NOX:   .19    .09    .07    .08    .06     .20     .32     .92     .02     .19
-------------------------------------------------------------------------------------

 CAL. YEAR: 1980       REGION: 49-STATE LOWALT.            ALT:  500. FT.
                            TAMB: 75.0(F)          30.0/ 27.3/ 30.0

VEH. TYPE:  LDGV  LDGT1  LDGT2   LDGT   HDGV    LDDV    LDDT    HDDV     MC   ALL VEH
VEH. SPD.: 18.0   18.0   18.0           18.0    18.0    18.0    18.0    18.0
  VMT MIX:   .778   .087   .046           .042    .005    .001    .033    .009

COMPOSITE EMISSION FACTORS (GM/MILE)
NO-MTH HC:  5.18   4.75   6.26   5.27  17.24     .76     .99    4.55    8.50    5.68
EXHST  CO: 55.69  48.92  54.83  50.97 264.74    1.76    2.36   14.64   32.85   61.92
EXHST NOX:  2.97   3.11   3.80   3.35   9.83    1.66    1.95   26.70     .49    4.05

HOT STABILIZED IDLE EMISSION FACTORS (GM/MIN)
NM-ID  HC:   .79    .62    .70    .65   1.02     .04     .10     .35    1.38     .77
 IDLE  CO: 14.02  10.71   9.07  10.15   9.90     .19     .34     .89    3.69   12.73
 IDLE NOX:   .19    .09    .07    .08    .06     .20     .32     .92     .02     .19
-------------------------------------------------------------------------------------

 CAL. YEAR: 1980       REGION: 49-STATE LOWALT.            ALT:  500. FT.
                            TAMB: 75.0(F)          30.0/ 27.3/ 30.0

VEH. TYPE:  LDGV  LDGT1  LDGT2   LDGT   HDGV    LDDV    LDDT    HDDV     MC   ALL VEH
VEH. SPD.: 21.0   21.0   21.0           21.0    21.0    21.0    21.0    21.0
  VMT MIX:   .778   .087   .046           .042    .005    .001    .033    .009
```

F-7 CALCULATION OF LEAD EMISSIONS

The composite lead emission factor is the sum of the products of fraction of annual travel per vehicle model year, fuel consumption expressed as gallons/mile, lead concentration expressed in grams/gallon and the fraction of lead emitted.

Figures derived from this calculation are treated as a general measure of vehicular lead emission; however, environmental and atmospheric factors and vehicle characteristics will affect the amount and location of total atmospheric lead.

I. Travel Fraction

Travel fraction is the percentage of annual travel for each vehicle (by model year) registered in Massachusetts, expressed as a fraction of the total sum of vehicle miles driven by registered cars in the state.

II. Fuel Consumption

Fuel consumption is one of the factors in the lead emission equation that is subject to interpretation. Fuel economy figures used in this analysis are based on figures used by Provenzano in a Journal of the Air Pollution Control Association article and are based on fuel economy figures calculated by Consumer Reports magazine. These values were derived from an examination of the fuel economy of the vehicle fleet in tests modeling actual road conditions.

Provenzano's estimates* of fuel economy per model year (city and highway) averaged about 15 percent lower than EPA estimates. That same 15 percent differential was used to estimate recent fuel economy estimates not directly provided by Provenzano. Figures for before 1967 are an average of 1967 to 1972 figures when fuel economy deviated very little from year to year. For purposes of the lead emission equation, fuel economy was expressed in gallons/mile.

III. Lead Concentration in Gasoline

Lead concentrations in gasoline, as several reports suggest, vary according to seasonal, geographical, and regulatory considerations. Unleaded gasolines after 1975 were defined as those having less than .05 grams/gallon of gasoline. Both Provenzano and an EPA study**assume that 95 percent of the autos built from 1975 on require unleaded gas. Figures for average lead concentration per gallon of gas are derived from EPA figures. The significant drop in grams/gallon after 1974 reflects the assumption that 95 percent of vehicles in that model year burned unleaded gas.

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*George Provenzano, "Motor Vehicle Lead Emissions in the U. S.," Journal of the Air Pollution Control Association, p. 1194, December 1978.

**U. S. Environmental Protection Agency, Supplementary Guidelines for Lead Implementation Plans; Revised Section 4.3 (Projecting Automotive Lead Emissions) July 1979.

IV. Fraction of Lead Emitted

Most sources have agreed on the emission factor of .70 for lead-fu burning vehicles, i.e., 70 percent of the lead burned is exhausted This figure is used by EPA in their guidelines for protecting automotive lead emissions*. This value was in the range of Provenzano's assigned rates of 60 percent for urban driving and 80 percent for highway driving. According to his study, a substantial amount of lead is retained in the engine, oil, and interior surfaces of the exhaust system when the vehicle is driven at slower speeds. As the vehicle grows older, Provenzano noted, emission rates climb as mileage increases.

The calculations in this report used the .70 figure.

V. Grams Per Vehicle Mile

The product of these factors is a figure for each model year of grams of lead emitted/vehicle mile. The composite of these model years yields an estimated .0676 grams of lead per vehicles mile traveled. Thus, an increase of 230,100 vehicle miles would increase regional lead concentration by about 34 pounds daily.

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*U. S. Environmental Protection Agency, Supplementary Guidelines for Lead Implementation Plans; Revised Section 4.3 (Projecting Automotive Lead Emissions) July 1979.

Other Sources: Airborne Lead Analysis for Highway Projects, Leonard F. Vik, Illinois Department of Transportation, Springfield, Illinois, June 1979.

Year	I Fraction of Annual Travel	II Fuel Consumption Gal./Mile	III Lead Concentration Grams/Gal.	IV Fraction of Lead Emitted	V (a)(b)(c)(d)
1980	.679	.06	.128	.70	.0036
1979	.1153	.06	.152	.70	.0007
1978	.1091	.07	.143	.70	.0008
1977	.0956	.07	.143	.70	.0007
1976	.0934	.07	.147	.70	.0007
1975	.0764	.07	.143	.70	.0005
1974	.0918	.08	2.26	.70	.0116
1973	.0930	.08	2.5	.70	.0130
1972	.0753	.08	2.5	.70	.0105
1971	.0545	.07	2.5	.70	.0067
1970	.0461	.07	2.9	.70	.0066
1969	.0295	.08	2.9	.70	.0048
1968	.0204	.07	2.9	.70	.0029
1967	.0117	.07	2.9	.70	.0017
1966	.0084	.07	2.9	.70	.0012
1965	.0051	.07	2.9	.70	.0007
1964	.0019	.07	2.9	.70	.0003
1963	.0017	.07	2.9	.70	.0002
1962	.0015	.07	2.9	.70	.0002
1961	.0013	.07	2.9	.70	.0002
				Composite	.0676

230,100 VMT x .0676 grams/vehicle mile = 15,554.76 grams/mile or
34.3 lbs./day

LEAD EMISSION CALCULATIONS

TABLE
F-17

F-8 CO HOT SPOT ANALYSIS - PARAMETERS

Carbon monoxide (CO) is a primary pollutant emitted directly by motor vehicles. The highest ambient concentrations can be found in the immediate vicinity of the emission sources, near areas of heavy traffic flow or congestion. The carbon monoxide verification procedure employed by CTPS focuses on the magnitude of CO concentrations that can be expected at a specific location taking into account the factors that directly effect concentrations in the vicinity of an emissions source.

CO Concentrations occurring in the immediate vicinity of a roadway or street can be attributed to two sources--1) a concentration directly attributable to the nearby roadway and 2) a background component that is attributable to all other emission sources. In Boston, a background concentration of 3.0 parts per million has been assumed.

The concentration of CO at any point is primarily a function of three factors: 1) the rate that CO is discharged into the air by the emission sources, 2) the forces that act to disperse the CO emitted into the air, and 3) the receptor location.

1) Emission Rates

The CO emission rates can vary greatly depending on various operational characteristics of the vehicle, such as engine speed, acceleration and deceleration rates, and environmental conditions.

Two emission rates are considered. The first--free-flow emissions--is defined as a constant quantity of emissions produced by a vehicle operating at a relatively constant cruise speed. The second--excess emissions--is that amount in addition to free-flow emissions produced while a vehicle is accelerating, decelerating, or idling.

The traffic environment directly determines the quantity of emissions produced. Some of the more important features of the traffic environment are the physical condition of the roadway or intersection (number of lanes, signals, turning lanes), the density and composition of traffic (number of trucks, number of right and left turns), and the location of the site in question. The various elements collectively determine the capacity of a roadway or intersection. Given this capacity and given traffic volumes, one can develop queue lengths and delay times, important parameters in the CO Hot Spot Analysis.

Another environmental consideration is ambient temperature, since emission rates rise as temperature falls. In doing the CO Hot Spot analysis, the worst-case condition, 20°F, is assumed.

2) Dispersion Characteristics

Local meteorological conditions greatly affect the CO concentrations. Atmospheric conditions can lessen the impact of heavy concentrations or create a Hot Spot where relatively few emissions occur.

The CO concentration is determined in part by the atmospheric stability. The level of turbulence determines the degree of vertical mixing which will occur between CO and the surrounding air. When mixing occurs, CO concentrations fall; when the air is relatively stable, conditions are unfavorable for mixing and CO concentrations rise. In the Hot Spot analysis, low vertical mixing, the worst-case condition, is assumed. Ground level obstructions, such as rough terrain, buildings, trees, and moving vehicles, sometimes create mechanical turbulence which act to increase mixing of CO with the surrounding air.

CO concentrations are inversely proportional to wind speed. As wind speed increases, CO levels fall. For one-hour concentration estimates, a wind speed of one meter per second is assumed; for eight-hour concentration estimates, a speed of three meters per second is assumed. These speeds simulate worst-case conditions.

Finally, wind direction is usually the most important factor affecting CO concentrations at a given location. It is assumed in the Hot Spot procedure that the wind is at an angle to the roadway that yields the highest CO concentration at the receptor site.

3) Receptor Location

To estimate the impact of carbon monoxide at an intersection, concentrations must be measured or estimated at a single-receptor location, chosen so as to register the highest concentrations to which the public would be exposed. An example location would be near the sidewalk nearest the highest volume intersection approach.

In the CO Hot Spot Analysis, the concentration of CO is a relative quantity--the quantity of CO relative to a quantity of ambient air. This is usually expressed as parts of CO per million parts air.

APPENDIX F - 9 : ESTIMATION OF VMT GROWTH

MEMORANDUM

Subject: Proposed Policy on VMT
Growth Projections

To: Air Quality Task Force

From: Data Subcommittee DE

Date: February 5, 1981

Action Required: Approval

The Data Subcommittee met on February 3 and dicussed VMT data and projections with representatives of MDPW. The subcommittee concluded that insufficient reliable data exists to derive RPA specific VMT growth rates. For RACM analysis RPAs should adopt the 2.3% statewide annual rate implied by MDPW's 1987 VMT projections and latest revised base year VMT. However, different project specific VMT projections may be used as long as their impacts are not so large as to conflict with RPA-wide use of the statewide rate.

The reasons for this recommendation are the following:

1. No superior alternative exists. Methods suggested by AQTF agencies include estimates by simulation using UTPS type models, and projections from estimates of fuel dispensed at gasoline stations. The Data Subcommittee believes these methods may be potentially less accurate than the MDPW procedure.

2. Historical data is not adequate to establish trends at the regional level and is even suspect as a basis for statewide projections. Previous experience is invalid due to rapid and continuing changes in energy supplies, fuel prices, vehicle fuel economy, and national economic trends. In addition, the inherent error margin in traffic counts used to check VMT figures is 10% or more. According to MDPW, the region specific growth rates prepared by the Planning Branch from 1977-80 data (tables dated 7/9/80) are not significantly different statistically from each other.

3. The 2.3% VMT growth rate was derived from prior estimates of 1987 and 1980 total VMT. MDPW checks VMT projections against traffic counts every two years. As MDPW acquires new data, including information gathered for NECROS, the base VMT figure may be revised, which would change the growth rate required to reach the projected 1987 total VMT. MDPW will reevaluate VMT trends periodically and revise the projected growth rate when necessary.

4. Sensitivity tests by the Planning Branch show that required emissions reductions are only moderately sensitive to the most divergent reasonable assumptions of VMT growth.

It is important to keep in mind that MDPW projects the absolute level of VMT in 1987 and derives a growth rate to reach that level, rather than assuming a growth rate in order to project 1987 VMT. Changes in estimated growth rates are attributable to a revised base year VMT. Since for emissions it is the absolute 1987 VMT that is important, RACM analyses should calculate impacts based on MDPW projected VMT, not on the basis of percentage growth rates, unless the rates used imply the same 1987 total VMT. An outline of the MDPW estimation method is attached.

This policy will not affect the relationship between emission reduction "targe and RACM impacts. The emission reduction targets are planning goals only and should not be considered as having legal force. The are subject to revision at any time. Target levels should not affect the adoption of RACMs since many other factors enter the decision to implement a project or mix of projects. RACMs must be implemented if they are feasible and effective, irrespective of the current numerical value of a reduction target.

DE/td

DEVELOPMENT OF REVISED ESTIMATE OF 1987 VMT

A. Estimate 1987 vehicle fleet size and composition (statewide).

B. Estimate 1987 fleetwide fuel economy (statewide average = 21.93 mpg).

C. Estimate 1987 fuel consumption for highway uses (statewide consumption for highway uses = 2060 million gallons).

D. From the above data, calculate AVMT for 1987 (statewide = 40.891 billion).

E. For each city/town and functional class, derive 1987 DVMT by applying the ratio of 1987 to 1980 statewide AVMT:

$$\frac{AVMT_{87}}{AVMT_{80}} = 1.1727708$$

$$DVMT_{87} = DVMT_{80} \times 1.1727708$$

F. Calculate annual compound growth rate from 1980 to 1987:

$(1.1727708)^{(1/7)} = 1.023$ or 2.3% annual VMT growth rate.

Appendix F-10 : Annual and Monthly Vehicle Counts (1982) for Selected Major Links

Initial Turnpike

Year	Passenger*	% of Year	Commercial**	% of Year	Non-Revenue	% of Year	Total	% Increase (Decrease)
1973	31,047,262	89.1	3,538,375	10.1	276,668	0.8	34,862,305	4.7
1974	28,968,407	88.7	3,461,345	10.6	228,889	0.7	32,658,641	(6.3)
1975	31,022,287	89.7	3,309,893	9.6	256,849	0.7	34,589,029	5.9
1976	33,286,190	89.4	3,688,371	10.0	240,049	0.6	37,214,610	7.6
1977	35,658,197	89.2	4,034,929	10.1	261,185	0.7	39,954,311	7.4
1978	37,707,148	89.0	4,360,252	10.3	292,559	0.7	42,359,959	6.0
1979	37,493,355	88.5	4,598,609	10.9	269,284	0.6	42,361,248	0.0
1980	37,379,284	88.9	4,426,786	10.5	250,477	0.6	42,056,547	(0.7)
1981	38,514,739	89.0	4,489,566	10.4	255,027	0.6	43,259,332	2.9
1982	41,048,345	89.4	4,567,783	10.0	276,117	0.6	45,892,245	6.1

Boston Extension

Year	Passenger*	% of Year	Commercial**	% of Year	Non-Revenue	% of Year	Total	% Increase (Decrease)
1973	44,586,912	92.8	3,195,130	6.6	284,999	0.6	48,067,041	2.7
1974	42,779,731	92.7	3,115,365	6.8	248,426	0.5	46,143,522	(4.0)
1975	44,742,515	93.4	2,908,282	6.1	260,820	0.5	47,911,617	3.8
1976	47,779,790	93.6	3,022,843	5.9	251,011	0.5	51,053,644	6.6
1977	50,466,768	93.8	3,104,678	5.7	246,891	0.5	53,818,337	5.4
1978	53,150,369	93.8	3,246,427	5.7	263,298	0.5	56,660,094	5.3
1979	54,729,776	93.8	3,388,444	5.8	250,858	0.4	58,369,078	3.0
1980	53,797,232	93.8	3,346,102	5.8	233,564	0.4	57,376,898	(1.7)
1981	55,356,824	94.0	3,311,278	5.6	231,816	0.4	58,899,918	2.7
1982	58,399,648	94.2	3,353,941	5.4	244,775	0.4	61,998,364	5.3

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*Automobiles, taxis, ambulances, motorcycles, hearses, light trucks.

**Trucks (dual tires with two axles; three or more axles), tandem trailers, buses.

Source: Massachusetts Turnpike Authority,

VEHICLE VOLUME COUNTS, MASSACHUSETTS TURNPIKE, 1973 - 1982

TABLE

Fiscal Year	Passenger				Commercial	% of Year	Total	% Increase (Decrease)
	Commutation	% of Year	Non-Commutation	% of Year				
1965	15,730,967	69.8	4,924,993	21.8	1,860,712	8.3	22,516,681	
1966	15,994,018	69.0	5,260,947	22.7	1,905,465	8.2	23,160,430	3
1967	16,072,005	68.5	5,675,234	24.2	1,703,717	7.3	23,450,956	2
1968	15,807,340	65.7	6,189,340	25.7	2,050,505	8.5	24,047,378	1
1969	15,559,707	63.7	6,694,999	27.4	2,169,669	8.9	24,424,375	2
1970	15,279,543	62.1	7,141,836	29.0	2,190,382	8.9	24,611,761	1
1971	15,143,398	61.0	7,455,279	30.0	2,242,915	9.0	24,841,592	0.6
1972	14,317,547	55.9	8,961,012	35.0	2,326,350	9.1	25,604,909	0.8
1973	14,001,769	55.0	8,993,357	35.3	2,449,433	9.6	25,444,559	(0.6)
1974*	8,379,471	51.3	6,214,346	38.0	1,733,051	10.6	16,326,868	(36)
1975	10,865,249	50.0	8,620,403	39.6	2,268,100	10.4	21,753,752	(15)**
1976	10,862,438	47.8	9,622,845	42.4	2,236,287	9.8	22,721,570	5
1977	10,655,753	46.5	9,955,676	43.4	2,316,850	10.1	22,928,279	0.1
1978	10,536,403	45.5	10,239,571	44.2	2,390,478***	10.3	23,166,452	1
1979	10,763,627	44.0	10,904,822	44.6	2,771,144	11.3	24,439,593	5
1980	10,930,547	43.4	11,478,104	45.6	2,752,910	10.9	25,161,561	3
1981	10,198,679	41.8	11,586,793	47.5	2,625,069	10.8	24,410,541	(3)
1982	10,302,894	40.0	12,711,545	49.4	2,739,792	10.6	25,754,231	6

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*During 1973, the bridge was closed for over two months in September, October, and November due to a truck accident.

**As compared with the total for FY1973

***No non-revenue vehicles included.

Source 44 Massachusetts Port Authority

TABLE F-19

VEHICLE VOLUME COUNTS, TOBIN MEMORIAL BRIDGE, 1965-1982

Sumner-Callahan Tunnels

Year	Passengers*				Commercial**	% of Year	Non-Revenue	% of Year	Total	% Increase (Decrease)
	Commutation	% of Year	Non-Commutation	% of Year						
1973	1,566,865	6.1	23,029,531	89.9	887,165	3.5	141,750	0.6	25,625,311	10.3
1974	1,499,455	6.1	22,267,641	90.5	698,854	2.8	143,403	0.6	24,609,353	(4.0)
1975	1,499,128	6.1	22,450,701	90.7	648,654	2.6	142,033	0.6	24,740,516	0.5
1976	1,451,344	5.6	23,556,263	91.2	667,514	2.6	144,136	0.6	25,819,257	4.4
1977	1,360,352	5.3	23,401,607	91.5	672,225	2.6	134,728	0.6	25,568,912	(1.0)
1978	1,231,806	4.6	24,393,274	92.1	696,656	2.6	136,658	0.5	26,458,394	3.5
1979	1,256,573	4.4	26,213,694	92.5	732,830	2.3	149,399	0.5	28,352,496	7.2
1980	2,012,759	7.3	24,806,569	89.7	671,763	2.4	167,799	0.6	27,658,890	(2.4)
1981	2,236,414	8.0	24,994,666	89.0	676,277	2.4	179,439	0.6	28,086,793	1.5
1982	2,118,744	7.5	25,290,895	89.4	707,509	2.5	180,518	0.6	28,297,666	0.8

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*Automobiles, taxis, ambulances, motorcycles, hearses, light trucks.

**Trucks (dual tires with two axles; three or more axles), tandem trailers, buses.

Source: Massachusetts Turnpike Authority

TABLE

VEHICLE VOLUME COUNTS, SUMNER - CALLAHAN TUNNELS, 1973 - 1982

Month	Passenger		Trucks	Non-Revenue	Total
	Total	Carpools			
January	2,689,726	19,287	328,613	20,960	3,039,299
February	2,707,017	18,565	327,517	18,837	3,053,371
March	3,128,363	21,883	391,108	21,432	3,540,903
April	3,231,407	19,632	375,225	21,650	3,628,282
May	3,577,589	19,352	388,886	23,809	3,990,284
June	3,531,820	20,550	410,662	25,397	3,967,879
July	3,821,140	18,006	380,665	26,185	4,227,990
August	4,045,483	19,305	409,341	25,519	4,480,343
September	3,723,103	20,297	405,886	24,470	4,153,459
October	3,699,184	19,904	401,840	23,545	4,124,569
November	3,491,350	19,024	378,508	22,012	3,891,870
December	3,402,163	18,851	369,532	22,301	3,793,996
TOTAL	41,048,345	234,656	4,567,783	276,117	45,892,245

Source: Massachusetts Turnpike Authority

TABLE F-21

MONTHLY VEHICLE VOLUME COUNTS ON THE INITIAL TURNPIKE, 1982

Month	Passenger		Trucks	Non-Revenue	Total
	Total	Carpools			
January	4,273,492	35,783	248,027	19,203	4,540,722
February	4,253,481	33,464	243,611	17,141	4,514,233
March	4,996,711	39,810	292,887	19,461	5,309,059
April	4,801,585	35,715	272,739	18,302	5,092,626
May	5,058,636	35,214	283,994	18,742	5,361,372
June	5,071,499	37,194	298,626	20,944	5,391,069
July	4,783,276	33,631	276,124	21,235	5,080,635
August	4,965,514	34,920	291,304	24,393	5,281,211
September	4,992,756	35,686	290,031	23,235	5,306,022
October	5,219,394	36,095	292,757	23,586	5,535,737
November	5,018,406	34,953	279,369	18,558	5,316,333
December	4,964,898	36,145	284,472	19,975	5,269,345
Total	58,399,648	428,610	3,353,941	244,775	61,998,364

CHARACTERISTICS OF THE MASSACHUSETTS TURNPIKE: BOSTON EXTENSION

Capacity - 5,850 vehicles per hour in each direction (three lane section)
- 7,800 - 8,000 vehicles per hour in each direction (four lane section)

1982 Average Weekday Traffic - 71,200 vehicles per day (west of the Central Artery; two-way traffic)

1982 Peak Hour Counts - 4,400 (AM, Eastbound)
- 3,180 (PM, Westbound)

Source: M.D.P.W. and The Turnpike Authority

MONTHLY VEHICLE VOLUME COUNTS, CHARACTERISTICS

TABLE

Month	Passenger		Trucks	Non-Revenue	Total
	Commutation	Non-Commutation			
January	773,222	816,777	186,425	14,368	1,790,792
February	756,937	857,086	184,521	13,299	1,811,843
March	876,913	1,008,836	215,597	15,778	2,117,124
April	813,273	1,012,574	205,413	14,804	2,046,064
May	896,463	1,099,857	212,733	15,331	2,224,384
June	896,453	1,092,258	218,977	15,315	2,223,003
July	857,320	1,215,903	218,127	14,678	2,306,028
August	888,324	1,254,929	231,169	14,733	2,389,155
September	882,305	1,113,991	221,977	14,239	2,232,512
October	905,938	1,135,165	226,386	15,435	2,282,924
November	875,228	1,048,161	218,002	16,026	2,157,417
December	880,518	1,056,008	220,962	15,497	2,172,985
TOTAL	10,302,894	12,711,545	2,560,289	179,503	25,754,231

CHARACTERISTICS OF THE TOBIN MEMORIAL BRIDGE

Capacity - 4,700 vehicles per hour in each direction

1982 Average Weekday Traffic - 72,500 vehicles per day (two-way volume)

1982 Peak Hour Counts - 3,060 (AM, Southbound)
- 3,120 (PM, Northbound)

Source:
Massachusetts Port Authority

MONTHLY VEHICLE VOLUME COUNTS, CHARACTERISTICS
TOBIN MEMORIAL BRIDGE, 1982

TABLE
F-23

Month	Passenger			Trucks	Non-Revenue	Total
	Commutation	Carpools	Non-Commutation			
January	174,247	1,837	1,916,451	54,952	14,923	2,162,410
February	167,633	1,691	1,849,248	55,207	14,134	2,087,913
March	194,754	2,004	2,188,312	64,513	16,064	2,465,647
April	177,425	1,883	2,098,400	56,710	14,807	2,349,225
May	186,098	2,144	2,218,307	60,323	15,362	2,482,234
June	176,573	2,326	2,617,163	60,776	15,384	2,422,222
July	162,700	1,952	2,180,181	56,087	13,437	2,414,357
August	166,995	2,146	2,226,322	58,193	13,379	2,467,035
September	176,322	2,166	2,092,892	59,034	15,749	2,346,163
October	181,400	2,065	2,185,150	61,563	16,054	2,446,232
November	176,998	2,045	2,052,160	59,119	15,396	2,305,718
December	177,599	1,934	2,092,036	61,112	15,829	2,348,510
TOTAL	2,118,744	24,193	25,266,622	707,589	180,518	28,297,666

CHARACTERISTICS OF THE SUMNER-CALLAHAN TUNNELS

Capacity - 3,100 vehicles per hour in each direction

1982 Average Weekday Traffic - 82,800 vehicles per day (two-way volume)

1982 Peak Hour Counts - 3,160 (AM, Southbound/Sumner)
- 2,850 (PM, Northbound/Callahan)

Source:

C.T.P.S., Massachusetts Turnpike Authority, M.D.P.W.

MONTHLY VEHICLE VOLUME COUNTS, CHARACTERISTICS

TABLE

Appendix F-11

Memo on Energy Efficiency Changes from the Manager of Energy Conservation of the MBTA

MASSACHUSET
BAY
TRANSPORTATI
AUTHORITY

o: R. L. Duvall
Chief Engineer

rom: R. F. Muehlberger

Date: August 22, 1983

SUBJECT: Energy Statistics 1978-1982

Attached is a set of graphs (6) prepared to illustrate trends in energy use, energy cost, energy use efficiency and energy prices between 1978 and 1982.

Energy Use

The first graph shows an overall 23% decline in gross energy use during the last two years. Gross energy includes the total fossil energy required at the source to produce the electric energy supplied to the system. The major contributor to this large decline was the conversion from self-generated power to purchased power; however, declines also occurred in the heating and automotive fuels.

This chart also depicts a modest decline in net energy output to the operating system. Net energy represents energy at the point of supply. Net electric energy declined by 10%, while heating fuels and automotive fuels each declined by approximately 14%.

Efficiency of Energy Use

The second graph shows the overall 20% decline in total system gross energy consumed per vehicle mile operated.

The third graph shows the variation in net energy consumed per vehicle mile which declined slightly in 1980 and 1982 but increased to a high level in 1981 (due to a 10% decline in mileage in 1981 coupled with base energy loads which are independent of vehicle mileage).

Energy Cost

The fourth graph shows the rapid increase in energy costs between 1978 and 1980 and the declines in 1981 and 1982. The six million dollar or 17% cost decline in 1982 is attributed to the electric power cost reductions realized from conversion to purchased power and reductions in power prices.

The fifth graph shows the sharp rise in energy cost per vehicle mile between 1978 and 1981 and the 19% decline in 1982 due to declines in energy use and prices.

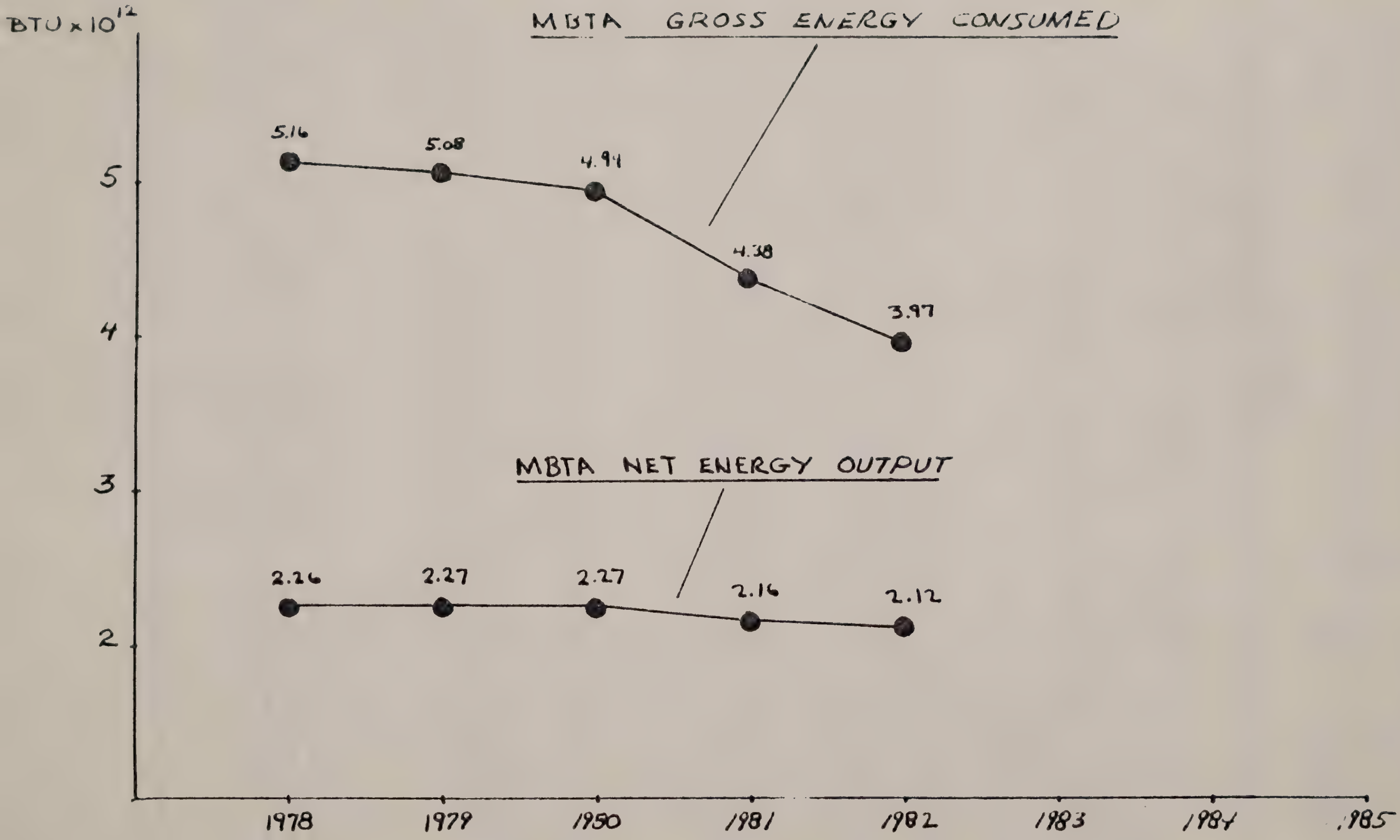
The last graph compares the cost per million BTU for the total system with the cost per million BTU of electric power, automotive fuels and heating fuels. This illustrates the dramatic impact of the conversion to purchased power on the unit cost for electric power which declined by 29% in 1982.

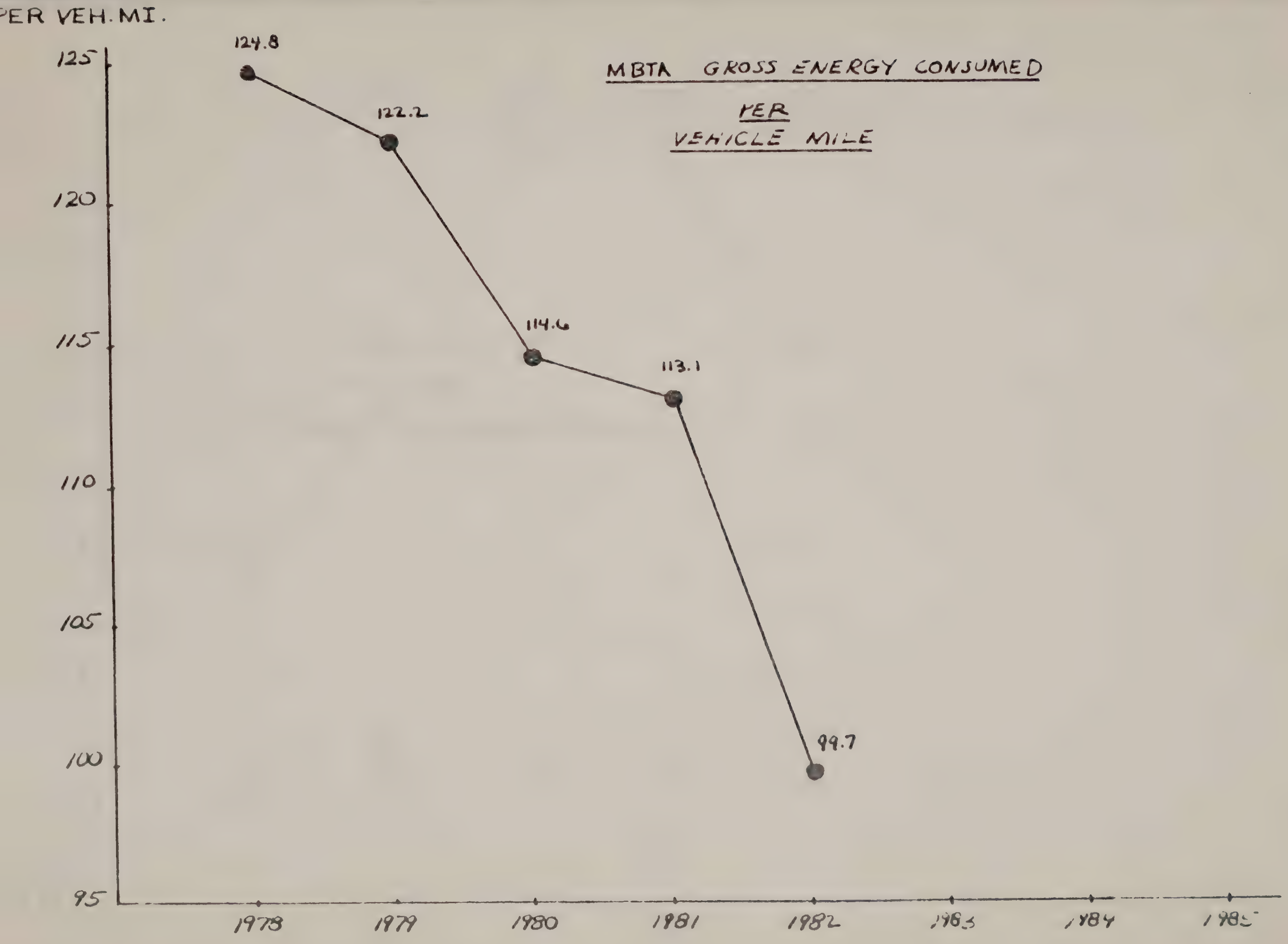
RF Muehlberger
R. F. Muehlberger
Manager of Energy Conservation

RFM/drm

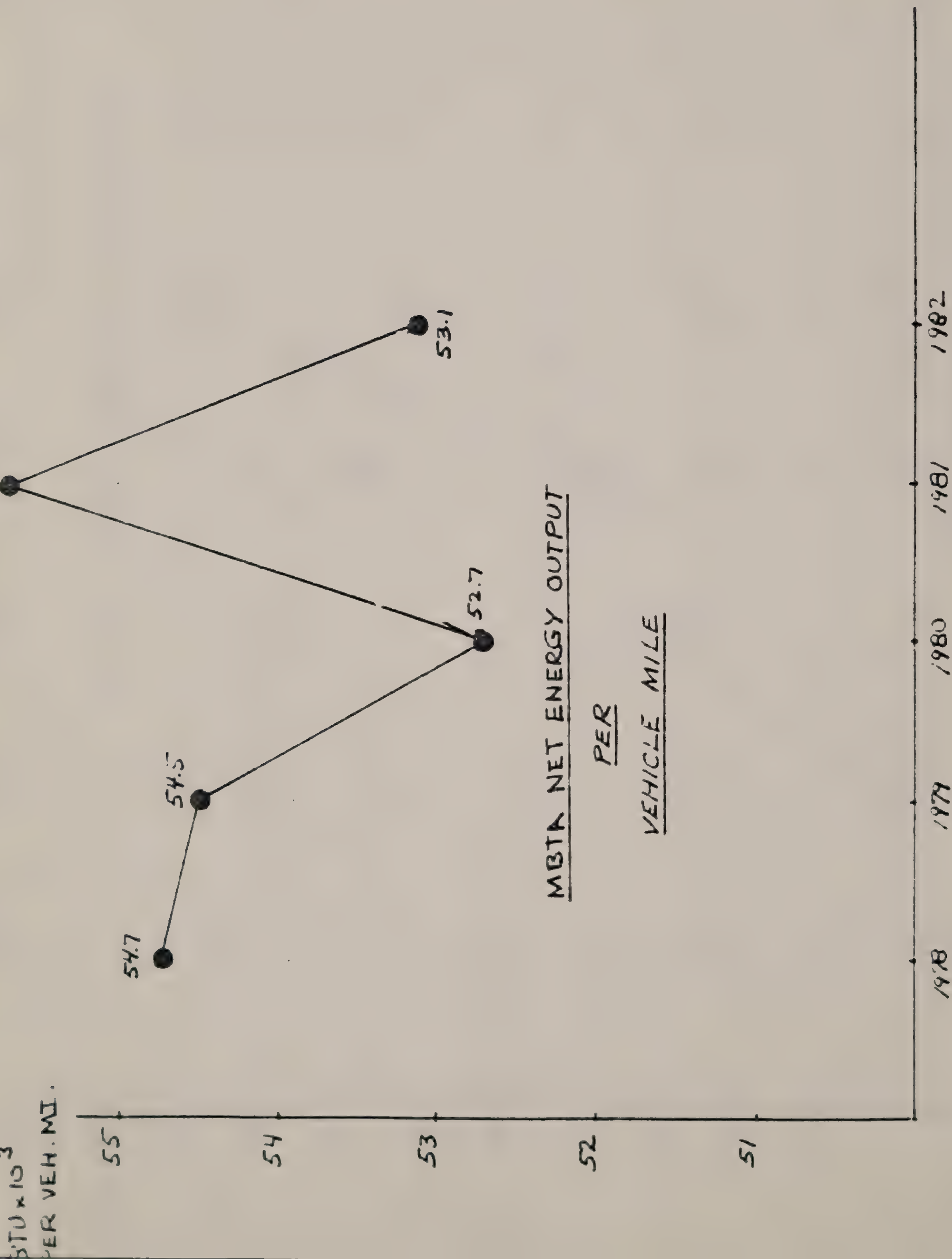
Attachments

cc: E. J. Rowe
O. R. Kelly
R. M. Brown

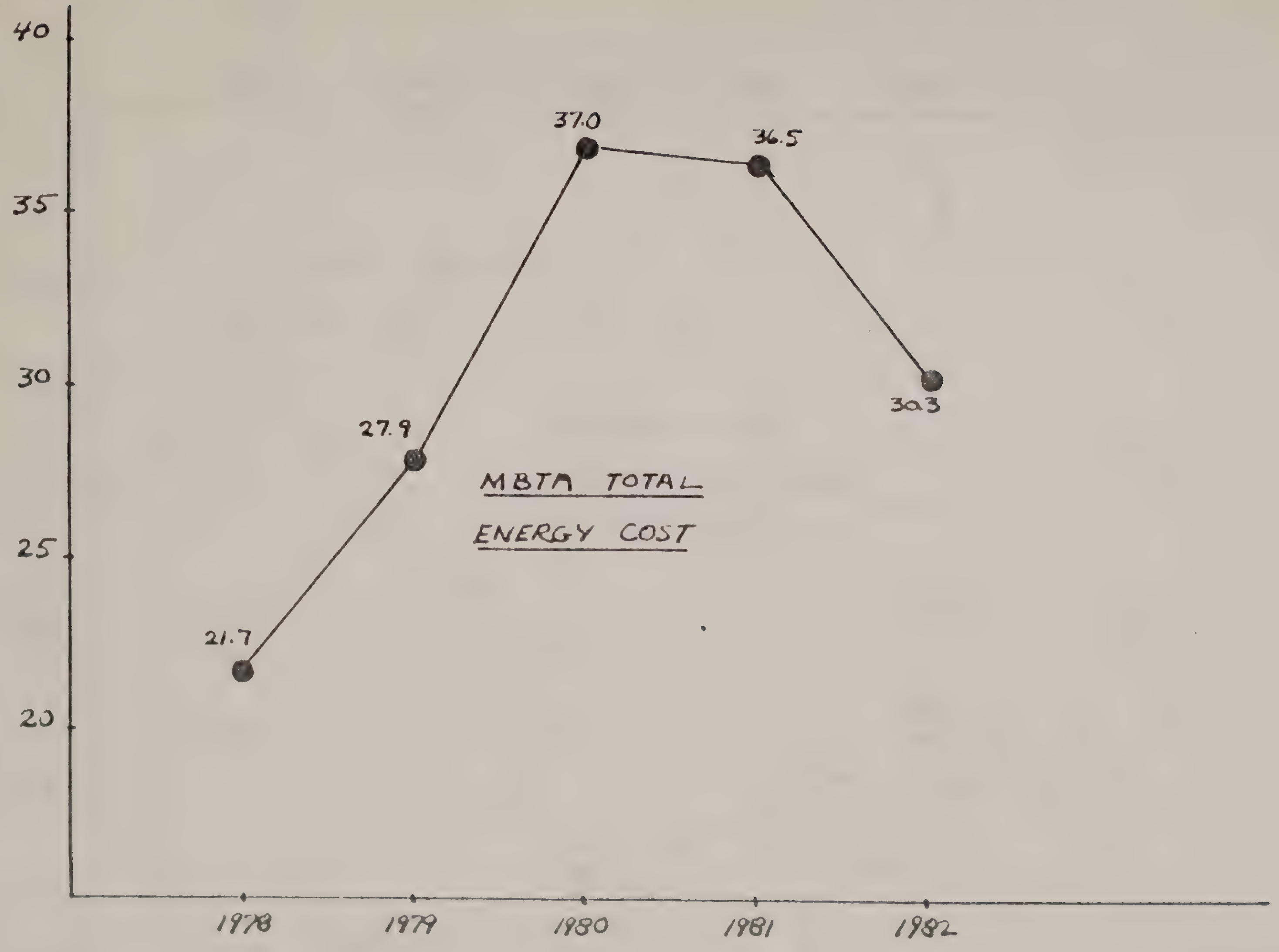

BTU x 10^12
MBTA GROSS ENERGY CONSUMED
MBTA NET ENERGY OUTPUT
5
4
3
2
5.16
5.08
4.94
4.38
3.97
2.26
2.27
2.27
2.16
2.12
1978
1979
1950
1981
1982
1983
1984
1985

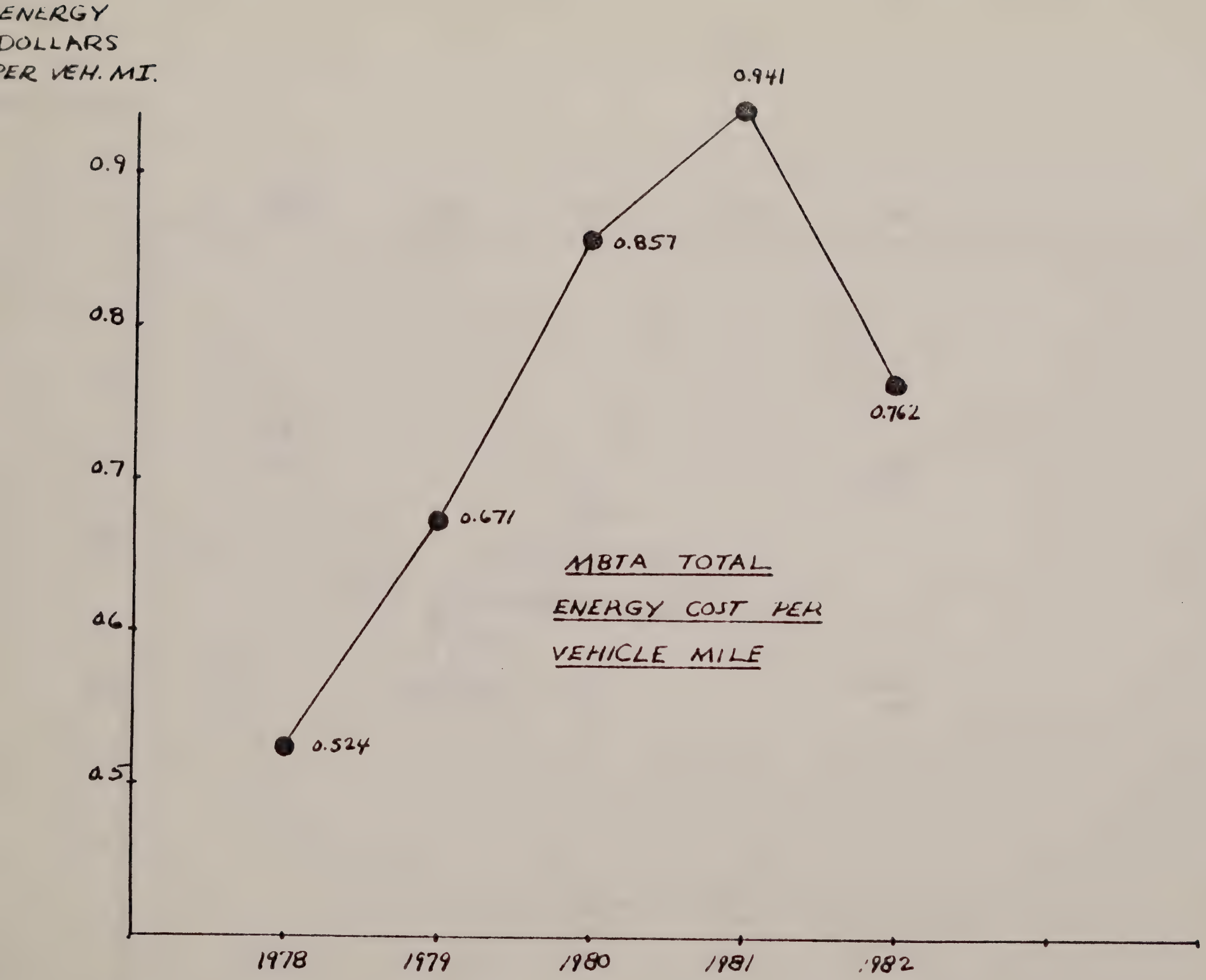


MBTA GROSS ENERGY CONSUMED PER VEHICLE MILE

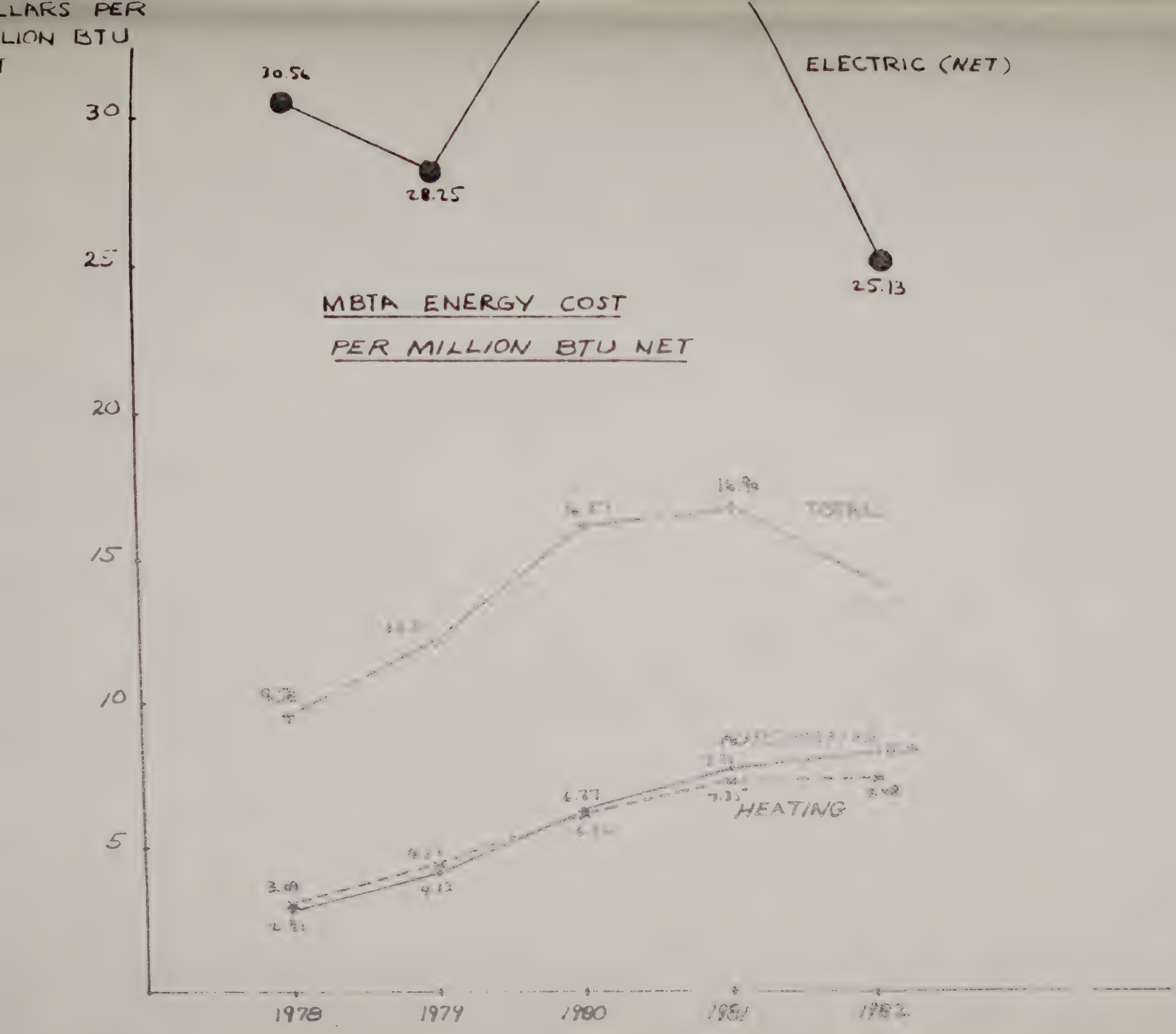


MBTA NET ENERGY OUTPUT PER VEHICLE MILE


MBTA TOTAL
ENERGY COST
40
35
30
25
20
1978
1979
1980
1981
1982
21.7
27.9
37.0
36.5
30.3



MBTA TOTAL ENERGY COST PER VEHICLE MILE



MBTA ENERGY COST PER MILLION BTU NET

APPENDIX G

Service Reduction Options

SERVICE REDUCTION OPTIONS NEEDED TO REMAIN WITHIN THE $344 MILLION ADVISORY BOARD BUDGET

As can be seen from the Supplemental Budget Request, TAB A, the
Running Rate" of the Authority is approximately $15 million higher than
e 1982 Advisory Board approved level of $344 million. The Advisory
ard has basically calculated their savings in the Labor category,
educing the Transportation Department's budget alone by $9 million in
rect wages (approximately $11 million when fringe is calculated) below
s 1981 Running Rate. The Automotive Department's Labor budget was
educed by approximately $2.6 million, including fringes. The next
argest discrepancy between the Advisory Board and the Authority's
unning Rate is in the area of Unfunded Debt and Fixed Charges, where
e Advisory Board has used optimistic interest rates to calculate a
avings of approximately $3.2 million.

If the Authority is to remain within the Advisory Board's approved
udget, the following types of service cuts of the magnitude described
ill be required:

	Savings
1. Effective April 1, 1982, per the attached list, reduce, combine or discontinue bus routes; thus, saving 81 Operators.	$2,080,000
2. Effective April 1, 1982, replace all PCC cars except on the Mattapan High Speed Line with LRV cars. Savings less mothballing - cost of approximately 70 employees, materials and services.	2,635,000
3. Reduce Commuter Rail by layoffs of maintenance personnel, shutdown of service or other combinations as presented in a separate impact statement of alternatives to be madeto the Board of Directors by the Director of Railroad Operations.	1,700,000
4. Effective April 1, 1982, curtail rapid transit service after 7:00 PM on the following lines and at the following stations:	
- Wonderland to Orient Heights - bus after 7:00 PM	170,000
- Orange Line - turn trains at Wellington after 7:00 PM	121,600
- Close the following stations after 7:00 PM and all day Sunday:	

Shawmut
Savin Hill
Kendall
Central North

	Savings
Harvard/Holyoke Green Street Dover Essex North and South Haymarket Orange Wood Island Lechmere (Pay on Car) Boylston Prudential (22 collectors)	$ 530,00
- Cease all LRV Operations on Huntington after 7:00 PM	50,00
5. Effective April 1, 1982, cut the use of the jet turbine backup by one-half, saving fuel.	300,00
6. Effective April 1, 1982, cut local service subsidies to Salem, Peabody and Winthrop.	400,00
7. Effective April 1, 1982, reduce planned hiring to maintain nine percent covers in Transportation; this will impact the number of dropped trips.	300,00
8. Attempt to contract more services now performed in our Rail and Automotive Shops, and cut fuel, utilities and materials use based on reduced service.	3,655,00
9 In a combination of the spring and summer timetables, reduce 19 Automotive Mechanics based on an approximately seven percent reduced service schedule, 39 Mechanics based on use of part-time individuals for bus refueling and 60 individuals involved in bus cleaning, which may be contracted. Net savings after part-time costs and contracts are calculated.	847,00
10. Reduce the Transportation budget in the spring, summer and fall tables by implementing service contracts for station and building cleaning, adding 140 part-time Operators, reducing the number of Starters, Gatemen and Porters. Net savings after service contract costs.	2,855,00
11. Eliminate fifteen Car Cleaners on the Green Line and implement cleaning contracts in the summer timetable. Net savings of contract costs.	93,00
12. In addition to the above, the Authority	

would have to generate, effective April 1, 1982, through Chapter 581 savings or a three percent cutback in Rail Equipment, Green Line, Automotive and Engineering and Maintenance, a savings equal to 60 individuals with fringe.	$2,000,000

The above savings total approximately $17.7 million. The difference
ween the approximately $15 million shortfall and the savings projects
ld be required for unemployment, Rail Equipment and Engineering and
ntenance scheduled work not budgeted for in 1981 Running Rates but
tical to 1982.

APPENDIX H

Population and Employment Changes

APPENDIX H

POPULATION AND EMPLOYMENT TRENDS BY SUBREGION

This appendix contains a comparison of subregional population and employment conditions and a forecast of future conditions. The source of this information as well as the following is: Employment Location in Greater Boston: 1970-2010, Metropolitan Area Planning Council, May 1982.

Comment on Population and Employment Forecast Relationships

Because of the additional women expected to enter the region's labor force during the next thirty years, employment in all subregions is forecast to increase. Population growth is projected for only four of the six subregions. Should the subregional pattern of these employment and population changes actually occur, there would be important implications for the journey to work. Commuter travel into the urban core (Inner 128) may increase, especially from the farther portions of the Northwest and Southwest subregions. In the North Shore, South Shore, and West subregions, forecasted employment increases will just about match population increases. There will be decreases in commuter movements from the inner 128 area into the downtown area with the exception of several western communities (Cambridge, Newton, Watertown, etc.). Generally, there will be greatly increased demand for intra-regional commuter travel.

Subregional Relationship of Population and Employment Changes: 1970-1980

EMPLOYMENT*	1970	1980	Change	Percent
Inner 128	688,195	830,991	142,796	21
North Shore	123,065	151,480	28,415	23
Northwest	24,382	48,188	23,806	98
West	71,561	108,565	37,004	52
Southwest	52,360	85,623	33,263	64
South Shore	42,107	67,020	24,913	59
POPULATION				
Inner 128	1,729,726	1,574,752	-154,974	-9
North Shore	466,303	449,238	-17,065	-4
Northwest	78,299	84,668	6,369	8
West	260,404	268,707	8,303	3
Southwest	230,348	239,062	8,714	4
South Shore	248,832	268,285	19,453	8

*Nongovernment only. Expansion in coverage during the decade makes growth overstated.

Source: Massachusetts Division of Employment Security and Metropolitan Area Planning Council, Appendix E, no. 3

Subregional Relationship of MAPC's Population and Employment Forecast: 1980-2010

	1980	2010	Change	Percent
EMPLOYMENT				
Inner 128	969,631	1,050,400	80,769	8
North Shore	175,938	188,500	12,562	7
Northwest	57,716	66,400	8,684	15
West	123,095	141,800	18,705	15
Southwest	101,371	119,000	17,629	17
South Shore	78,620	90,400	11,780	15
POPULATION				
Inner 128	1,574,752	1,485,100	-89,652	-6
North Shore	449,238	445,600	- 3,638	-1
Northwest	84,668	102,100	17,432	21
West	268,707	290,900	22,193	8
Southwest	239,062	275,200	36,138	15
South Shore	268,285	285,800	17,515	7

Source: Massachusetts Division of Employment Security and Metropolitan Area Planning Council, Appendix E, No. 3

ubregional Projected Population and Employement (1980-2010)

Table H-2

Appendix I

Glossary

APPENDIX I - GLOSSARY

Captive Rider.--A traveler limited by circumstances to one mode of transportation. In some case, this includes a traveler who must use a private automobile.

In relation to transit, the term is used to identify a traveler who does not have an automobile available for a trip and must use public transit.

Cash Gates.--These are gates in rapid transit stations which have a farebox but no turnstile. They are used regularly at 10 locations in the MBTA system and may be open at other stations due to broken turnstiles or passemters. The flow of passengers through the gates is monitored by a gateman stationed at the gate.

Cold Start.--A pollution concern; high pollution rates occur when a motor vehicle is started after being off for at least four hours (one hour for a catalyst-equipped vehicles).

Collectors Turnstiles.--These are the turnstiles with a farebox located adjacent to the collectors booth and are controlled by the collector. Only elderly, handicapped or other authorized free riders and students are permitted to use these turnstiles; the recent sampling program has snown both full fare adults and adult passholders using them also.

Combination (Surface and Rapid Transit) Trip.--This is a trip made using both a surface vehicle and a rapid transit line. In each case, a transfer between the two types is made.

Congestion.--Loosely, crowdedness viewed as undesirable. Strictly, a facility may be said to be congested (seriously or significantly) when the time taken to traverse (or be processed by) the facility becomes (seriously or significantly) dependent on the demands on the facility.

Constant Dollars.--A series is said to be expressed in "constant dollars" when the effect of change in the purchasing power of the dollar has been removed. Usually the data are expressed in terms of dollars of some selected year or the average of some set of years.

Consumer Price Index (CPI).--An index issued by the U. S. Department of Labor, Bureau of Labor Statistics. The CPI is designed to measure changes in the prices of goods and services bought by wage earners and clerical workers in urban areas. It represents the cost of a typical consumption bundle at current prices as a ratio to its cost at a base year price.

Crush Capacity.--The capacity of a vehicle, including standing passengers, at which no other passengers can enter. Presumably, the maximum capacity.

Current Dollars.--Dollars current at the time designated or at the time the transaction listed took place. In most contexts, the same meaning would be conveyed by the simple term "dollars."

Demand-Responsive.--In transportation planning, demand-responsive services normally meet the needs of single passengers or small groups of passengers in response to their specific requests for service at a specific time and location.

Elasticity Analysis.--A fare elasticity is the percentage change in ridership in response to a percentage change in fare. For example elasticities were applied to base 1981 ridership levels to predict the effects of the fare increase of August 1981. The relationship of the predicted post-fare increase ridership level to the base, pre-fare increase ridership level was used to derive a new base ridership level after a more accurate determination of post-fare increase levels was made.

Environmental Impact Statement.--A document required by the National Environmental Policy Act. All federal agencies must prepare such a statement of the significant environmental effects of all major proposals.

Inelastic.--Having an elasticity of less than one. If demand for a product is inelastic, one will spend more money on it as its price goes up. In the extreme case of inelasticity--called perfect inelasticity or zero elasticity--one would buy the same amount of a product regardless of its price.

Linked Rapid Transit Only Trip.--This includes those trips made using only a rapid transit line.

Linked Surface Only Trip.--This includes those trips made using only surface vehicles. It includes trips which are made using two or more surface vehicles. These each count as one linked trip.

Off-Peak.--This term is variously understood. In some cases, it refers to any period of travel outside the peak period. In other cases, it refers to any period or travel outside the peak-hour but excluding the base period. In yet other cases, it is the opposite of peak; that is, it refers to that period in which the least travel occurs on a system.

Operating Costs.--To be distinguished from capital cost. Those recurring costs in a transportation system, such as salaries and wages, maintenance, energy, taxes, insurance, and supplies.

Passenger Mile.--Or passenger kilometer. The measure of the transportation of one passenger, one mile (or kilometer).

Peak Hour.--The hour during which the maximum traffic occurs.

Revenue Passenger.--A passenger who pays a fare. This might seem obvious, but in some areas the number of non-fare-paying passengers can be significant: public employees who use passes, transportation system employees who ride to and from work (at rush hour) without paying fares, and so on.

Trip.--A one-direction movement which begins at the origin at the start time, ends at the destination at the arrival time, and is conducted for a specific purpose.

Trolley Bus.--Sometimes called electric bus or trolley coach. A bus powered from overhead electric lines. Since it does not run on a track, it can maneuver in mixed traffic much like an ordinary bus.

Unlinked Rapid Transit Trips.--These are any trips made on a rapid transit line, including the underground portion of the Green Line.

Unlinked Surface Trips.--These trips include any trip made on a bus, trackless trolley, or the surface portion of the Green Line.

Wilbur Smith - 1978 Survey.--This is a survey which was distributed during the fall and spring of 1978 to passengers on the entire MBTA system. It is the most recent source of information available on the proportion of trips which are combination, rapid transit, or surface only trips.

Bibliography

BIBLIOGRAPHY

Barton-Aschman Associates, Inc., Traveler Response to Transportation System Changes, Second Edition, for FHWA (Washington, D. C., Barton-Aschman Associates, July 1981.

Brög, Werner and Förg, Otto G., "What Public Transportation Management Should Know About Possible User Reactions, As Shown by the Example of Price Sensitivity," Transportation Research Record 746 - Bus Transit Management and Performance, Transportation Research Board, Washington, D. C., 1980.

Central Transportation Planning Staff, Prospectus: 1979-1980, Transportation Planning in the Boston Region, Boston, 1979.

Central Transportation Planning Staff, Technical Report No. 26, MBTA Systemwide Passenger Data Collection Program, Volume 1: Rapid Transit System, April 1981.

Commonwealth of Massachusetts, Interim Report of the Special Commission Established to Make an Investigation and Study Relative to the Finances and Operation of the Massachusetts Bay Transportation Authority, March 1970, Senator James R. McIntyre, Chairman.

Commonwealth of Massachusetts, Executive Office of Transportation and Construction, Reorganization Legislation, Phase II, March 1973.

Decision Research Corporation, Dime Time Ridership, Study No. 2, for MBTA, (Wellesley Hills, Massachusetts; Decision Research), June 1974.

Dygert, Holec, and Hill, Public Transportation Fare Policy, for U. S. Department of Transportation, (Washington D. C., Peat, Marwick, Mitchell, and Co.), December 1976.

Falcocchio, John C., and Cantelli, Edmund J., Transportation and the Disadvantaged, Lexington Books, Washington D. C., Heath and Company, Lexington, Massachusetts, 1974.

Federal Highway Administration, U. S. Department of Transportation, Traveler Response to Transportation System Changes, Second Edition, July 1981.

Goodman and Green, Low Fare and Free Fare Transit, for UMTA, (Washington, D. C., The Urban Institute), February 1977.

Governor's Task Force on Transportation, A. Altshuler, Chairman, Report to Governor Sargent, Part II, June 1970.

Hartgen and Weiss, "Differential Time of Day Transit-Fare Policies: Revenue, Ridership, and Equity," in Transit Planning and Operations, TRB 625, Washington, D. C., 1977.

Hershey, W. R., et al, Transit Fare Prepayment, Urban Mass Transportation Administration, Washington, D. C., August 1976.

Hoel, Lester A., et al, Latent Demand for Urban Transportation, Transportation Research Institute, Carnegie, Mellon University, Pittsburgh, Pennsylvania, 1968.

Holland, Dempster K., A Review of Reports Relating to the Effect of Fare and Service Changes in Metropolitan Public Transportation Systems, Federal Highway Administration, Washington, D. C., June 1974.

Kemp, Michael A., Reduced Fare and Fare-Free Urban Transit Services Some Case Studies, The Urban Institute, Washington, D. C., July 1974.

Kingham, R. Ian, An Application of Mode Choice Methodologies to Infrequent Commuter Rail Service, Transportation Research Board, National Research Council, Washington, D. C., January 1976.

Levinson, Herbert, et al, "Estimating Behavioral Response to Peak-Period Pricing," Transportation Research Record 767, Transportation Research Board, Washington, D. C.

Massachusetts Bay Transportation Authority, 1981 Current Expense Budget and Auxiliary Data, Boston, 1981.

Massachusetts Bay Transportation Authority, The Legal Structure and Management of the MBTA, October 1980.

Massachusetts Bay Transportation Authority, Title VI Assessment for Capital and Operating Assistance, December 1981.

Massachusetts Bay Transportation Authority Advisory Board, Public Transportation Financing - A Survey of Options for Alternatives to the Property Tax Which Has Hampered Massachusetts Economic Development, Staff Draft, October 1976.

Mayworm, Lago, and McEnroe, Patronage Impacts of Changes in Transit Fares and Service, for UMTA, (Washington, D. C.; Ecosometrics, Incorporated), September 1980.

Mundle, Subhash, et al, "Transit Price Elasticities," in Compendium of Technical Papers, 48th Annual Meeting Institute of Transportation Engineers, Atlanta, Georgia, August 1978.

Palmere, Anthony J., Alternatives for Financing the MBTA, (unpublished thesis), John F. Kennedy School of Government, Harvard University, April 1981.

Provenzano, George, "Motor Vehicle Lead Emissions in the United States: An Analysis of Important Determinants, Geographic Patterns and Future Trends," in Journal of the Air Pollution Control Association, December 1978.

Pucher, John, et al, "Socioeconomic Characteristics of Transit Riders: Some Recent Evidence," Traffic Quarterly, Volume 35, No. 3, July 1981.

Pucher, John, "Equity in Transit Finance - Distribution of Transit Subsidy Benefits and Costs Among Income Classes," Journal of the American Planning Association, Volume 47, No. 4, October 1981.

Scheiner, James I., "The Patronage Effects of Free-Fare Transit," Traffic Quarterly, Eno Foundation for Transportation, January 1975.

Southern California Association of Governments, Transit Safety and Security - A Design Framework, April 1976.

State of New York Metropolitan Transportation Authority, Draft Environmental Impact Statement, Metropolitan Transportation Authority's Proposed Fare Actions, May 1981.

Transportation Policy Workshop Department of City and Regional Planning, Harvard University, Evaluation of Alternative Fare Structures for the Massachusetts Bay Transportation Authority, Cambridge, Massachusetts, May 1980.

Transportation Research Board, National Academy of Sciences, Transportation Research Record 719 - Transit Development, Washington, D. C., 1979 (following articles):

Hajek, J. J., "Revenue and Ridership Changes in Ontario Cities Caused by Transit Fare Increases,"

Parody, Thomas E., and Brand, Daniel, "Forecasting Demand and Revenue for Transit Prepaid Pass and Fare Alternatives,"

Politano, Marlene Rodenbeck, and Keck, Carol A., "Operating Assistance for Public Transportation Systems: A Survey of State-Level Programs,"

Ugolik, Wayne R., and Leutze, Clark B., "Who Pays the Highest and the Lowest Per Kilometer Transit Fares."

Transportation Research Board, National Academy of Sciences, Transportation Research Record 799 - Transit Fare Policies, Washington, D. C. (following articles):

Robert Cervero, "Efficiency and Equity Impacts of Current Transit Fare Policies,"

Doxsey, Lawrence B., and Spear, Bruce D., "Free Fare Transit: Some Empirical Findings,"

Lago, Armando M., et al, "Further Evidence on Aggregate and Disaggregate Transit Fare Elasticities."

Transportation Research Board, National Academy of Sciences, *Urban Transportation Economics: Special Report 181*, Washington, D. C., 1978 (following articles):

Addison, Walter J., "Case Studies on Increasing Transit Revenues: Baltimore,"

Bates, John W., "Using Sales Tax to Support Low-Fare Pricing of Transit Services in Atlanta,"

Burbank, Cynthia J., "Transit Financing Trends and Outlook,"

Dahms, Lawrence D., "Increasing Transit Revenues,"

Hill, Terrell W., "Case Studies on Increasing Transit Revenues: Atlanta,"

Olson, David, et al, "The Problem of Funding Transit,"

Reading, James E., Case Studies on Increasing Transit Revenues: Columbus,"

Schofer, Ralph E., "Elasticity of Transit Demand with Respect to Price: A Case Study in Northern Virginia,"

Smith, Joseph C., "Reducing Transit Costs,"

Woodhull, Joel, "Case Studies on Increasing Transit Revenues: Southern California,"

Yuratovac, Donald G., "Case Studies on Increasing Transit Revenues: Cleveland."

Tri-State Regional Planning Commission, *The Effect of Fare Changes on Public Transportation Ridership and Revenues*, New York, New York, 1980.

U. S. Environmental Protection Agency, *Supplementary Guidelines for Lead Implementation Plans Revised Section 4.3 (Projecting Automotive Lead Emissions)*, Research Triangle Park, North Carolina, July 1979.

Urban Mass Transportation Administration (UMTA), U. S. Department of Transportation, *Efficiency and Equity Implications of Alternative Transit Fare Policies*, September 1980.

Urban Mass Transportation Administration, *Guidelines to Reduce Energy Consumption Through Transportation Actions*, May 1974.

Urban Mass Transportation Administration, U. S. Department of Transportation, *Short-Range Transit Planning, Bus Service Evaluation Procedures: A Review*, Washington, D. C., March 1979.

Urban Mass Transportation Administration, U. S. Department of Transportation, Transit Pricing Techniques to Improve Productivity, Proceedings of the March 1979 Forum on Recent Advances and New Directions.

Vik, Leonard F., "Airborne Lead Analysis for Highway Projects," for presentation at the 72nd Annual Meeting of the Air Pollution Control Association, Illinois Department of Transportation, Springfield, Illinois: June 1979.

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